

Abstracts

Huitu, O. & Henttonen, H. (eds.)

EVPMC9

22.-27.9.2013

Turku, Finland



Vertebrate Pest Management Conference

The 9th European Vertebrate Pest Management Conference

Abstracts

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Foreword

Dear participants of EVPMC9

It is my great pleasure to welcome you to Turku, Finland, for the Ninth European Vertebrate Pest Management Conference (EVPMC9). The Finnish Forest Research Institute and the University of Turku are proud to have the opportunity to provide a forum for ca. 130 delegates from 30 countries across the globe to discuss their work and recent advances in the fields of basic research in vertebrate biology and ecology, methodology and legislation and their application in wildlife management.

Our current location is the northernmost in which EVPMC has been organized – previous hosting countries include the UK, Germany, Israel, Italy, Hungary and France. Here in Northern Europe, both ecosystems and challenges associated with wildlife management differ in many aspects from those of Central and Southern Europe, let alone those in the tropics. Yet, in more ways than one, our ultimate aims and means are similar – we all strive to balance the maintenance of ecosystem functioning on one hand with the prevention of economic, health or aesthetic losses to pest species.

The presentations selected for EVPMC9 comprise a superb review of vertebrate pest management research topics across the world, not only Europe. We can be particularly pleased with the latitudinal breadth of research topics on offer – the conference will provide a unique opportunity for scientists from all diverse corners of the world, north and south, to convene and address their respective management issues together with the novel eyes of newly-found colleagues.

EVPMC9 has required a great deal of work before the conference even took off. I would like to extend my sincerest gratitude to my fellow members of the local organizing and scientific committee, the international steering committee (especially Jens Jacob, Grand Maestro of EVPMC Berlin 2011), the University of Turku Congress Office, and student assisting staff. I'd also like to especially thank all our plenary speakers, session chairs and, last but not least, all presenters for their participation and invaluable contribution to the scientific quality of EVPMC9.

As delegates, your main task towards making this conference a success begins at the Get-Together event on Sunday 22nd of September. We hope that, from that point on, you will contribute to the scientific quality of the conference by relaxing, enjoying what the beautiful city of Turku has to offer, and most importantly, engaging with colleagues in discussions aiming to advance research in the field of vertebrate pest management.

Tampere, 2nd September, 2013
Otso Huitu, chair of EVPMC9

Committees

Local scientific and organizing committee

Dr. Otso Huitu, chair, Finnish Forest Research Institute
Prof. Heikki Henttonen, vice-chair; Finnish Forest Research Institute
M.Sc. Sinikka Jortikka Finnish Forest Research Institute
Dr. Kaarina Kauhala, Finnish Game and Fisheries Research Institute
Prof. Erkki Korpimäki, University of Turku, Finland
Dr. Toni Laaksonen, University of Turku, Finland
Prof. Pekka Niemelä, University of Turku, Finland
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Dr. Petri Nummi, University of Helsinki, Finland
Prof. Kari Saikkonen, Agrifood Research Finland
Dr. Päivi Salo, University of Turku, Finland

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Dave Cowan, UK
Chris Feare, UK
Otso Huitu, Finland
Jens Jacob, Germany
Herwig Leirs, Belgium
Hans-Joachim Pelz, Germany
Colin Prescott, UK
Emil Tkadlec, Czech Republic

Scientific Program

SUNDAY 22 nd SEPTEMBER 2013		
17:00-21:00	Registration @ Pharmacy	
19:00-22:00	Get-together event @ Pharmacy	
MONDAY 23 rd SEPTEMBER 2013		
08:15-08:30	Opening words, Pharma 1, <i>Otso Huitu</i>	
08:30-09:30	PLENARY, Pharma 1: What principles has academic rodent research contributed to solutions for vertebrate pest management? <i>Charles Krebs</i>	
	AGRICULTURAL PEST MANAGEMENT, Pharma 1 Session chairs: Jens Jacob & Rory Putman	CHEMICAL CONTROL – METHODS AND ALTERNATIVES, Pharma 2 Session chairs: Hans-Joachim Pelz & Colin Prescott
09:30-09:50	O1. Common vole outbreaks in Germany: economic significance and management options, <i>Jens Jacob</i>	O12. Development of a bird repellent: screening of plant extractions, <i>Joanna Dürger</i>
09:50-10:10	O2. Movement and home range of multi-mammate mouse, <i>Mastomys natalensis</i> in irrigated rice field in eastern Tanzania, <i>Loth Mulungu</i>	O13. Are cafeteria experiments with free ranging animals a useful tool for repellent testing? <i>Juho Matala</i>
10:10-10:40	COFFEE	COFFEE
10:40-11:00	O3. Habitat use of field voles (<i>Microtus agrestis</i>) in wide and narrow riparian buffers, <i>Kai Norrdahl</i>	O14. Rodenticide developments and new delivery systems, <i>Charles Eason</i>
11:00-11:20	O4. Endophytic fungi – defensive plant mutualists? <i>Kari Saikkonen</i>	O15. Genetic distance of Norway rats (<i>Rattus norvegicus</i>) on a local scale in the Y139C-resistance area in Westphalia, Germany, <i>Alexandra Esther</i>
11:20-11:40	O5. Food habits of the indian crested porcupine (<i>Hystrix indica</i> Kerr, 1792) in rainfed Pothwar plateau Punjab, Pakistan, <i>Shahid Hafeez</i>	O16. Mutations of the VKORC1 gene in Norway rats (<i>Rattus norvegicus</i>) – locating and delimiting anticoagulant resistance foci in South East England, <i>David Rymer</i>
11:40-12:00	O6. Residues of anticoagulant rodenticides in small non-target mammals and foxes in Germany, <i>Anke Broll</i>	O17. Assessment of resistance factors to second generation anticoagulant rodenticides by BCR-tests in the homozygous anticoagulant resistant strains Y139C and Y139F of the Norway rat, <i>Stefan Endepols</i>
12:00-13:00	LUNCH	LUNCH
13:00-14:00	PLENARY, Pharma 1: Damage to agriculture and other impacts of large ungulates: when do game ungulates become more of a burden than a benefit and what are the options for managing those impacts? <i>Rory Putman</i>	
	ECOLOGICALLY BASED PEST MANAGEMENT, Pharma 1 Session chairs: Grant Singleton & Steve Belmain	CHEMICAL CONTROL – METHODS AND ALTERNATIVES, Pharma 2 Session chairs: Hans-Joachim Pelz & Colin Prescott
14:00-14:20	O7. Prospects for ecologically-based management of rodent population outbreaks: can we mitigate 50-year cyclic famine in South Asia? <i>Steven Belmain</i>	O18. Vitamin K requirement of two VKORC1 resistant Norway rat (<i>Rattus norvegicus</i>) strains common in Belgium: Y139F and L120Q, <i>Kristof Baert</i>
14:20-14:40	O8. A multi-country experiment of rat and weed interactions in Asia: ecological studies assist our quest for increased future food security, <i>Grant Singleton</i>	O19. Target Resistance to VKA - Part 1 - An overview about the catalytic mechanism of VKORC1 enzyme, <i>Etienne Benoit</i>
14:40-15:00	O9. Do wolves (<i>Canis lupus</i>) help protect forest regeneration from ungulates? <i>Zbigniew Borowski</i>	O20. Target Resistance to VKA - Part 2 - An overview about the catalytic consequences of VKORC1 mutations, <i>Etienne Benoit</i>
15:00-15:30	COFFEE	COFFEE
15:30-15:50	O10. Ecological applications of airborne laser scanning - analyzing habitat preferences and behavior of moose (<i>Alces alces</i>), <i>Markus Melin</i>	O21. Resistance to Vitamin K antagonists. Two phenotypes for one rVKORC1 mutation (L120Q mutation), <i>Virginie Lattard</i>
15:50-16:10	O11. VECMAP, a one-stop-shop for vector mapping, <i>Guy Hendrickx</i>	O22. Consequences of spontaneous mVKORC1 mutations on the resistance phenotype, <i>Joffrey Goulois</i>
16:10-16:30		O23. Linking predator exposure and patterns of treatments with anticoagulant rodenticides by using faeces, <i>Marion Jacquot</i>
16:30-16:50		O24. Stewardship of anticoagulant rodenticides in the United Kingdom and in Ireland, <i>Colin Prescott</i>

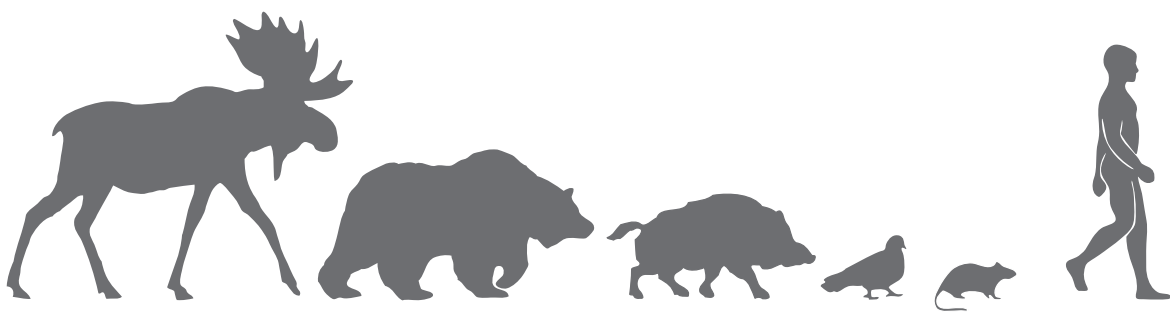
TUESDAY 24 th SEPTEMBER 2013		
08:30-09:30	PLENARY, Pharma 1: Optimising strategic, large scale control of non-native American mink: a fine Scottish blend of population ecology, people and ambition, <i>Xavier Lambin</i>	
	INVASIVE VERTEBRATE PESTS, Pharma 1 Session chairs: Pålvi Salo & Lise Ruffino	SILVICULTURAL PEST MANAGEMENT, Pharma 2 Session chairs: Pekka Niemelä & Otso Huitu
09:30-09:50	O25. The impact of ranch escapee American mink on feral populations, <i>Agnieszka Niemczynowicz</i>	O37. How does variation in moose population and forest resources explain moose damage in Finland? <i>Ari Nikula</i>
09:50-10:10	O26. Eradication of American mink in the Finnish archipelago - a success story, <i>Mikael Nordström</i>	O38. Mitigation of damage caused by wild ungulates in low-land forest and farmland: an example from southern Poland, <i>Bogusław Bobek</i>
10:10-10:40	COFFEE	COFFEE
10:40-11:00	O27. Eradication of invasive mammals on islands - factors predicting success, <i>Andrea Zanetta</i>	O39. Varying impacts of cervid, hare and vole browsing on growth and survival of boreal tree seedlings, <i>Mari Lyly</i>
11:00-11:20	O28. Adaptive management of invasive Norway rats (<i>Rattus norvegicus</i>) on the Calf of Man to conserve Manx shearwaters (<i>Puffinus puffinus</i>), <i>Mark Lambert</i>	O40. Increasing vole numbers cause more lethal damage to saplings in tree monocultures than in mixed stands, <i>Sonja Gilbert</i>
11:20-11:40	O29. Eradications as scientific experiments: first attempt to eradicate two major invasive taxa, <i>Rattus rattus</i> and <i>Carpobrotus</i> spp. from a Mediterranean island, <i>Lise Ruffino</i>	O41. Short and long term effects of vole damage to birch seedlings, <i>Heikki Henttonen</i>
11:40-12:00	O30. Eradication of rodents and rabbits from sub-Antarctic Macquarie Island, <i>Keith Springer</i>	O42. Effects of climate change on population dynamics of bank voles, <i>Jens Jacob</i>
12:00-13:00	LUNCH	LUNCH
13:00-14:00	PLENARY, Pharma 1: European ungulates as pest species; what goes around comes around, <i>Göran Ericsson</i>	
	INVASIVE VERTEBRATE PESTS, Pharma 1 Session chairs: Pålvi Salo & Lise Ruffino	URBAN PEST MANAGEMENT, Pharma 2 Session chairs: Anita Plenge-Bönig & Daniel Bajomi
14:00-14:20	O31. The role of Norway rat (<i>Rattus norvegicus</i>) predation in determining breeding success of Manx shearwaters (<i>Puffinus puffinus</i>) on the Scottish island of Rùm, <i>Mark Lambert</i>	O43. Rat management: improvements in the city of Zurich, Switzerland, <i>Marcus Schmidt</i>
14:20-14:40	O32. Vertebrate pest management initiatives in the Southern Ocean, <i>Keith Springer</i>	O44. Population management of overpopulated rock hyraxes (<i>Procavia capensis</i>) in residential areas, <i>Roelof Wiid</i>
14:40-15:00	O33. RHD-Boost - strengthening rabbit control in Australia, <i>Glen Saunders</i>	O45. Anticoagulant resistance in Norway rats in an urban park in Paris: influence of anticoagulant exposure, <i>Philippe Berny</i>
15:00-15:30	COFFEE	COFFEE
15:30-15:50	O34. Ponto-Caspian gobies in Switzerland - science meets management, <i>Irene Kalchauer</i>	O46. The impact of bait boxes on house mouse (<i>Mus domesticus</i>) bait uptake in UK domestic dwellings, <i>Gai Murphy</i>
15:50-16:10	O35. Applied research as a basis for sustainable management of non-native gobies, <i>Patricia Burkhardt-Holm</i>	O47. Laboratory test for efficacy of six rodenticides against bank voles (<i>Myodes glareolus</i>), <i>Erik Schmolz</i>
16:10-16:30	O36. Estimating the risks related to non-native fish species - first application of FISK, the Freshwater Fish Invasiveness Screening Kit, in Southern Finland, <i>Riikka Puntila</i>	O48. Can second-generation anticoagulant rodenticides increase the frequency of resistant animals in natural populations of Norway rats? <i>Philippe Berny</i>
18:30-19:30	City reception @ Turku City Hall (Aurakatu 2)	

WEDNESDAY 25 th SEPTEMBER 2013	
08:30-09:30	PLENARY, Pharma 1: Vertebrate pests and their management in urban areas: a historical perspective, <i>Timo Vuorisalo</i>
	ZOONOSES AND PARASITES, Pharma 1 - Session chairs: Annapaola Rizzoli & Heikki Henttonen
09:30-09:50	O49. Negative relationship between abundances of two ticks: biotic interaction or niche segregation? <i>Emil Tkadlec</i>
09:50-10:10	O50. Identifying the hazards correlated with rodent and tick-borne diseases in Europe, <i>Annapaola Rizzoli</i>
10:10-10:40	COFFEE
10:40-11:00	O51. Insectivore-borne hantaviruses in Finland, <i>Tarja Sironen</i>
11:00-11:20	O52. Life-long shedding of Puumala hantavirus in wild bank voles (<i>Myodes glareolus</i>), <i>Liina Voutilainen</i>
11:20-11:40	O53. Factors influencing human Puumala virus infections in Germany, <i>Daniela Reil</i>
11:40-12:00	O54. Biome specific epidemiologies of Puumala hantavirus in Europe, <i>Heikki Henttonen</i>
12:00-13:00	LUNCH
13:00-18:00	Mid-conference excursion to Kurjanrahka N.P., buses leave from Pharmacy
THURSDAY 26 th SEPTEMBER 2013	
08:30-09:30	PLENARY, Pharma 1: Biology of wolf-human conflict in Fennoscandia, <i>Ilpo Kojola</i>
	HUMAN-ANIMAL SOCIAL CONFLICTS, Pharma 1 - Session chairs: Toni Laaksonen & Pjotr Danilov
09:30-09:50	O55. Management of cormorant populations: A tool to handle cormorant-fisheries conflicts? <i>Alexandra Hyldgaard</i>
09:50-10:10	O56. Beaver dispersal in man-made watercourses in Karelia and its consequences, <i>Fyodor Fyodorov</i>
10:10-10:40	COFFEE
10:40-11:00	O57. Fallow deer of Lemnos Island: current situation and alternatives for sustainable management, <i>Mariama Mattila</i>
11:00-11:20	O58. Baltic seals – balancing between sustainable ecosystem management and fisheries (ECOSEAL), <i>Raisa Tiilikainen</i>
11:20-11:40	O59. Analysing Baltic grey seal (<i>Halichoerus grypus</i>) population management options, <i>Lauri Ronkainen</i>
11:40-12:00	O60. Demographic structure and body condition of Baltic grey seals: are the problem seals a random sample of the population? <i>Kaarina Kauhala</i>
12:00-13:00	LUNCH
13:00-14:00	PLENARY, Pharma 1: Fertility control and translocations to mitigate human-wildlife conflicts, <i>Giovanna Massei</i>
	HUMAN-ANIMAL SOCIAL CONFLICTS, Pharma 1 Session chairs: Toni Laaksonen & Pjotr Danilov
14:00-14:20	O61. Assessment of the illegal use of poisoned baits for pest control and their impact on wildlife on the island of Crete (Greece), <i>Stavros Xirouchakis</i>
14:20-14:40	O62. Large predators – distribution, number, management and relationships with humans in the Russian North-West, <i>Pjotr Danilov</i>
14:40-15:00	CLOSING REMARKS
15:00-15:30	COFFEE
15:30-16:30	POSTER SESSION @ Pharmacy
18:00-23:00	Conference banquet @ Pikku-Pukki island, cruise boat departs from west bank of Aurajoki river (Läntinen rantakatu 35) at 18:00

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Plenary presentations



Monday 23rd September 2013, 08:30–09:30, Pharma 1

What principles has academic rodent research contributed to solutions for vertebrate pest management?

Charles Krebs

University of British Columbia, Vancouver, B.C., Canada

Studies of rodent populations have been spearheaded in large part by academic ecologists looking for projects that are well suited to the 3–4 year time frame of the postgraduate Ph.D. student thesis. These studies have produced a high level of understanding that is the envy of all ecologists lumbered with the need to study long-lived larger vertebrates or rare species. But in a world devoted to practical matters, it pays us to ask how useful all this elegant research has been for the applied ecologist dealing with pest management questions. I contend that the major contribution of rodent research has been to erect a theoretical skeleton of population dynamic principles within which pest management problems can be analysed and solved. In this talk I will list ten principles of applied population ecology which research on rodents has helped to establish over the last 60 years, the evidence for each of these principles and the gaps in our knowledge. These principles include the quantitative analysis of population dynamics, the experimental determination of top-down and bottom-up factors in causing population changes, the consequences of habitat simplification and landscape fragmentation, and the responses of rodent populations to lethal control measures. Pest management represents a collision of ecology with social science, and while we can specify the ecological laws by which vertebrate populations operate, we cannot always fit these easily into what humans desire without the wisdom of Solomon.

Monday 23rd September 2013, 13:00–14:00, Pharma 1

Damage to agriculture and other impacts of large ungulates: when do game ungulates become more of a burden than a benefit and what are the options for managing those impacts?

Rory Putman^{1,2}

¹Institute of Biodiversity, University of Glasgow, Glasgow, UK, ²Department Animals in Science and Society, University of Utrecht, Utrecht, The Netherlands

In this paper, I will explore the potential impacts of ungulates on agriculture through grazing and browsing of arable crops and as vectors of disease for domestic livestock, while introducing briefly other impacts such as damage to forestry, implication in road traffic accidents etc. I will review what information is available on the economic significance of such impacts across Europe, but focusing particularly on more detailed case-studies within the UK. Within such context I will explore whether or not we may be able to identify threshold densities at which impacts may become significant - where monitoring or management effort should thus be intensified. Such exploration will highlight that density of ungulate populations is not itself sufficient to predict whether or not impacts in a given situation are acceptable, or potentially damaging, and that impacts will be affected also by numerous other ecological (and economic) factors. Management of ungulate impacts in general is traditionally through attempts at reduction of population numbers of 'pest' species, or in agricultural contexts through exclusion of ungulates from vulnerable crops by fencing. But it is apparent that impacts are, for the most part, only weakly related to ungulate density; thus while culling may have some effect in controlling population numbers, it may be appropriate to consider a range of alternative approaches for managing those impacts more directly. Indeed it is suggested that we might expect to decouple control of herbivore populations and control of damage, deploying different, though complementary, approaches to achieve essentially separate goals.

Tuesday 24th September 2013, 08:30–09:30, Pharma 1

Optimising strategic, large scale control of non-native American mink: a fine Scottish blend of population ecology, people and ambition

Xavier Lambin

University of Aberdeen, Aberdeen, Scotland, UK

Optimising the effectiveness of attempts to control invasive species is urgent. American mink management in Scotland currently focuses on two approaches: intensive and systematic trapping using a team of professional trappers to achieve eradication in the Western Isles and landscape-scale (~20,000 km²) population reduction leading to eventual extinction using a monitoring network of mink rafts, operated mainly by volunteers in NE Scotland. In this talk, I will evaluate the achievement and challenges faced by both approaches and the contribution that science can make to improving effectiveness. Volunteers monitor rafts and then set traps only following detection of mink presence. This provides rich data on the residual distribution and abundance of mink, including the extent of recolonisation of previously cleared areas and how this decreases with the scale of control efforts. An enduring challenge is maintaining a sufficient spatial coverage of rafts in the face of low mink density and the potential loss of motivation by volunteers. We experiment with computer generated feedback to volunteers to contextualising the meaning of volunteer's observation and improve retention. Professionals follow a more systematic trapping design but, until recently, this yielded no information on the number of mink that escaped capture and progress towards eradication. We analysed mink capture histories to estimate the size and dynamics of the culled Western Isles mink population and show that after 7 years, eradication is likely but much uncertainty remains. Throughout, collecting, analysing and conveying scientific evidence is crucial to the success of mink eradication and ecosystem restoration.

Tuesday 24th September 2013, 13:00–14:00, Pharma 1

European ungulates as pest species; what goes around comes around

Göran Ericsson

SLU; Swedish University of Agricultural Sciences, Umeå, Sweden

A major focus of today's nature resource management is managing the interactions between people and wildlife. All management is based on human values, with "management" itself being a human construct. We thus manage wildlife because the society we live in view them as a resource - e.g. recreation, outdoors, hunting - or as something that affect societies and humans negatively - e.g. by browsing, grazing, or being hazards, or vectors for zoonoses. The world, and particularly western countries, has during the most recent ca. fifty years witnessed a successful restoration of wildlife. In several countries modern legalization promoting animal conservation together with habitat preservation has resulted in a strong return of ungulates. Europe is no exception to this development. The European countries have been particularly successful in getting large and charismatic vertebrate species back. Success stories include moose, roe deer, red deer and wild boar. Also exotic, non-native species have been introduced like white tailed deer to Finland. In my talk I will review the past, current and future of European ungulates as pest species. I will focus on the term pest in relation to population development and distribution, and further elaborate on browsing and grazing species.

Wednesday 25th September 2013, 08:30–09:30, Pharma 1

Vertebrate pests and their management in urban areas: a historical perspective

Timo Vuorisalo

University of Turku, Turku, Finland

Vertebrate pests have coexisted in cities with humans since the onset of urbanization several thousand years ago. Some vertebrate populations in cities compete with humans for food resources, spread zoonotic diseases, damage buildings and plantations, cause hygiene problems, or cause aesthetic or other kind of harm, and are therefore considered as pests. ‘Pest’ is a strongly culture-dependent concept, and therefore its application to particular species varies greatly both geographically and temporally. A species may be classified as a pest in one place (or time), and be a highly valued game species in another place (or time). Historically, pest problems in cities have been promoted by urban agriculture and animal husbandry, increasing organic waste production associated with poor waste management, and generally low hygiene levels. It seems that pest problems caused by for instance rodents have sometimes been regarded by city officials as overwhelming. This is shown by the fact that in Europe great urban fires were sometimes considered as partially useful because of resulting eradication of pest populations. Severity of vertebrate pest problems in cities is also indicated by the establishment of bounty schemes for pest control purposes. Due to change in human attitudes, some species earlier considered as pests, such as the red fox, are now well-liked representatives of urban biodiversity.

Thursday 26th September 2013, 08:30–09:30, Pharma 1

Biology of wolf-human conflict in Fennoscandia

Ilpo Kojola

Finnish Game and Fisheries Research Institute, Oulu, Finland

Wolves, once extirpated by humans in almost every country in Western Europe, have recently expanded their distribution range. Wolves have returned as breeding populations also to Finland and Scandinavia and have come into conflict with humans. This has led to e.g. anti-wolf civil campaigns and poaching. The primary conflicts between wolves and humans in all Nordic Countries are depredation in semi-domesticated reindeer herds, attacks on domestic dogs and occurrence in human-dominated landscapes. Owing to considerable distances and more liberal harvest policy in the area of reindeer management the exchange of wolves between Finnish and Scandinavian populations is only occasional. Wolves may regard dogs as competitors for prey and treat dogs. Moose is the primary prey of wolves in Northern Europe and densities within Finnish wolf territories are 3–5 times lower than in Scandinavia. Results revealed in a linear model provided evidence that the density of primary prey can influence the rate at which wolves attack domestic dogs. As a result of recent expansion, a few breeding territories are located in landscapes that are highly fragmented by human settlements and agricultural land. Overall, wolves avoid human residences. The most important reason increasing wolf positions close to houses was the high density of human residences. Hunters may consider wolves as competitors for ungulates. The hunter harvest on moose should be reduced by 30–50% inside wolf pack territory to avoid unintentional decrease in moose numbers. Due to low moose densities, this might cause a bigger concern in Finland than in Scandinavia.

Thursday 26th September 2013, 13:00–14:00, Pharma 1

Fertility control and translocations to mitigate human-wildlife conflicts

Giovanna Massei
AHVLA, York, UK

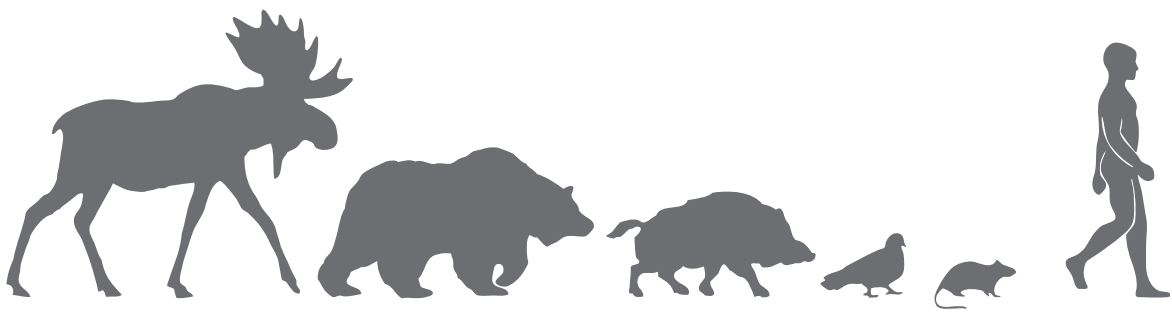
Current trends in human and wildlife population growth and in landscape development show that human-wildlife conflicts are likely to escalate. This is particularly important for Europe, where the density of the human population is relatively high and several wildlife species have increased in numbers and range. In parallel, heated debate about how to mitigate these conflicts will continue, with public opinion often polarised and with different groups holding irreconcilable views. Lethal control, traditionally used to manage wildlife populations, can be ineffective in the long term, unfeasible, illegal in some contexts or unacceptable for its impact on the environment and on animal welfare. Non-lethal options such as translocation of problem animals and fertility control are increasingly advocated as humane, effective and socially acceptable solutions to manage human-wildlife conflicts. The first part of this presentation will offer an overview of factors that, in Europe, are likely to be responsible for the increase of human-wildlife conflicts. The second part will illustrate recent advances in research and development on translocation of problem animals and on fertility control as well as advantages and limitations of these methods. The third part will identify research gaps, applications and contexts for non-lethal methods to manage wildlife and offer a decisional framework to guide choices when considering methods to mitigate the impact of wildlife on human activities.

Agricultural Pest Management

Oral presentations

Monday 23rd September 2013, Pharma 1

- | | |
|-------------|--|
| 09:30–09:50 | O1. Common vole outbreaks in Germany: economic significance and management options, <i>Jens Jacob</i> |
| 09:50–10:10 | O2. Movement and home range of multi-mammate mouse, <i>Mastomys natalensis</i> in irrigated rice field in eastern Tanzania, <i>Loth Mulungu</i> |
| 10:10–10:40 | COFFEE |
| 10:40–11:00 | O3. Habitat use of field voles (<i>Microtus agrestis</i>) in wide and narrow riparian buffers, <i>Kai Norrdahl</i> |
| 11:00–11:20 | O4. Endophytic fungi – defensive plant mutualists? <i>Kari Saikkonen</i> |
| 11:20–11:40 | O5. Food habits of the indian crested porcupine (<i>Hystrix indica</i> Kerr, 1792) in rainfed Pothwar plateau Punjab, Pakistan, <i>Shahid Hafeez</i> |
| 11:40–12:00 | O6. Residues of anticoagulant rodenticides in small non-target mammals and foxes in Germany, <i>Anke Broll</i> |



O1. Common vole outbreaks in Germany: economic significance and management options

Jens Jacob

Julius Kühn-Institut, Federal Research Centre for Cultivated Plants, Vertebrate Research, Münster, Germany

Common voles (*Microtus arvalis*) are widely distributed in European agricultural habitats. They can cause significant pre-harvest damage during population outbreaks. In contrast to *Microtus* and *Myodes* species in other parts of Europe there is no dampening of common vole cycles in Germany. During the last 10 years there were three major outbreaks (2004/5, 2007, 2012). These outbreaks mostly affected central Germany but also other regions suffered dramatic vole damage. Surveys indicated that damage occurred in 400,000–650,000 ha cropped area resulting in losses of >130 million euros per outbreak. In Federal States where damage was most severe 21–37% of cropped land was affected. Field rodents are usually controlled by rodenticide application. While outbreak frequency and intensity have not been changing in the last decade there were increasing restrictions on which rodenticidal compounds and products can be used. As a result 18 products are available presently to control rodents in the plant protection sector whereas 94 products were registered in 2000. For field use against common voles only zinc phosphide is registered in the EU. Alternatives for common vole management that can be used at a large-scale are scarce and mainly restricted to tilling and vegetation management in refuge habitats. Other approaches including bio-control through predation seem to have little effect. Therefore, efforts are required to develop and test alternative methods including novel compounds, fertility control and barriers as well as integrated approaches to manage common vole populations effectively, economically and sustainably.

O2. Movement and home range of multi-mammate mouse, *Mastomys natalensis* (Smith 1834) in irrigated rice field in eastern Tanzania

Loth Mulungu¹, Victoria Ngowo², Mashaka Mdangi³, Abdul Katakweba¹, Protas Tesha², Furaha Mrosso⁴, Magaret Mchomvu^{2,4}, Benny Borremans⁵

¹Sokoine University of Agriculture, Morogoro, Tanzania, ²Rodent Control Centre, Ministry of Agriculture, Food Security and Cooperatives, Morogoro, Tanzania, ³MATI-Ilonga, Morogoro, Tanzania, ⁴Ilonga Agricultural Research Institute, Morogoro, Tanzania, ⁵University of Antwerp, Antwerpen, Belgium

A 2 year study was conducted to estimate home range and movement of *Mastomys natalensis* (Smith 1834) in an irrigated rice ecosystem. Estimated home range size for both males and females in both habitats were the same. Adults had larger home ranges than subadults, but home ranges of adults were smaller than those of subadults in rice fields. Similarly, the home ranges of adult females in rice fields were smaller than those of adult males, whereas for subadults this pattern was reversed. Males move longer distances than females while both sexes had larger travel distances with lower number of recaptures in rice fields than in fallow land and had lower travel distance at maturity stage than at transplanting stage. Clearly, the invasion of fields by rodents from fallow land populations to rice fields should be a focus for managing rodent damage to rice crop by applying poison in a band around the fields and synchronised with crop growth stages in order to prevent quick invasion by the transient.

O3. Habitat use of field voles (*Microtus agrestis*) in wide and narrow riparian buffers

Sonja Gilbert, Kai Norrdahl
University of Turku, Turku, Finland

The extent of herbivore damage on plants is related to the habitat selection of herbivores and their predators. The habitat selection of field voles (*Microtus agrestis*) was studied using radiotelemetry in riparian buffers in an agricultural landscape in SW Finland. The riparian buffers were manipulated in a multifactorial design by mowing and providing supplementary food and cover. The aims of the study were to establish relative roles of food and cover for vole habitat use and to determine possible differences in habitat use between filter strips (5 m) and buffer zones (>15 m). Additionally, seasonal differences in habitat use in these ecosystems were studied. Habitat use was measured in terms of home range size and habitat selection functions based on compositional analysis. Home range sizes tended to be larger and distances moved longer in narrow than in wide buffers. Riparian buffer width had a significant impact on the use of available habitats. Habitats with natural vegetative cover were preferred to other available habitat types, particularly in wide buffers. Voles in the filter strips used crop fields and mowed areas significantly more than voles in buffer zones. Home ranges were smallest in winter and largest in autumn. There were no clear seasonal differences in the proportional use of crop fields and buffer zones. These findings suggest that mowing a patch between primary vole habitat (high grassy vegetation) and economically valuable plants may reduce damage caused by these herbivores as they do not readily cross mowed patches of several meters.

O4. Endophytic fungi – defensive plant mutualists?

Kari Saikkonen
MTT Agrifood Finland, Jokioinen, Finland

Endophyte-plant symbiosis has become synonymous with ubiquitous “defensive plant mutualism” since the mid 1970s when livestock disorders, associated with feeding on tall fescue variety “Kentucky 31”, were found to be attributable to alkaloids produced by fungal endophytes. Today these epichloid fungi comprising *Neotyphodium* endophytes and their sexual antecedents in the genus *Epichloë* are known to form a lifelong systemic infection throughout the above-ground parts of many pooid grasses. In a series of bioassays, we examined how feeding on *Neotyphodium* endophyte infected (E+) and endophyte free (E-) meadow ryegrass (*Scherodonius pratensis*) affects performance of field voles (*Microtus agrestis*) and sibling voles (*Microtus levis*), and whether diet mediates the vulnerability of voles to their natural enemies. We found that field voles feeding on endophyte infected grass lost body mass, while voles feeding on non-infected meadow ryegrass gained mass. More interestingly, grazing on E+ grass alters the ultraviolet spectrum of vole urine potentially enhancing its visibility to avian predators. In contrast to field voles, neither body mass of sibling voles nor population growth differed between E+ and E- diets. However, least weasels (*Mustela nivalis nivalis*) preyed more often on voles fed with E- grass than on voles fed with E+ grass. These results suggest that consumption of E+ diet can be advantageous to sibling voles by reducing risk of mammalian predation. Our study is the first to demonstrate the effects of plant-associated fungal symbionts on herbivore-predator interactions in vertebrate communities.

O5. Food habits of the indian crested porcupine (*Hystrix indica* Kerr, 1792) in rainfed Pothwar plateau Punjab, Pakistan

Shahid Hafeez, Malik Aitzaz, Muhammad Ul-Hassan
University of Agriculture, Faisalabad, Pakistan, Punjab, Pakistan

The study examined the food habits of the Indian crested porcupine (*Hystrix indica*) in rainfed Pothwar plateau, Punjab, Pakistan. There is a little knowledge of the food habits of Indian crested porcupine which is an important vertebrate pest in agriculture and forestry system of Pakistan. In the present study, twenty *H. indica* were killed to examine their stomach contents and sixty faecal pellets were collected. Both the stomach contents and faecal pellets showed correlation with feeding sites, plant material and the nature of food material that was consumed from cultivated and non-cultivated lands. The results of analysis of faecal pellets and stomach contents revealed that eleven species of plants were consumed by the porcupine as its food in rainfed Pothwar plateau. The study also showed that the diet of porcupine varied and comprised mainly of vegetable matter. The diet items included were tubers, roots, stem, spikes and leaves of agricultural crops like *Hordeum vulgare*, *Triticum aestivum*, *Zea mays* and *Sorghum vulgare*. Bark of *Acacia modesta* was eaten extensively according to the percentage of food items of faecal and stomach contents. During this study it was also observed that *H. indica* is the serious pest of agricultural crops and trees of this area.

O6. Residues of anticoagulant rodenticides in small non-target mammals and foxes in Germany

Anke Broll^{1,3}, Alexandra Esther¹, Detlef Schenke², Jens Jacob¹
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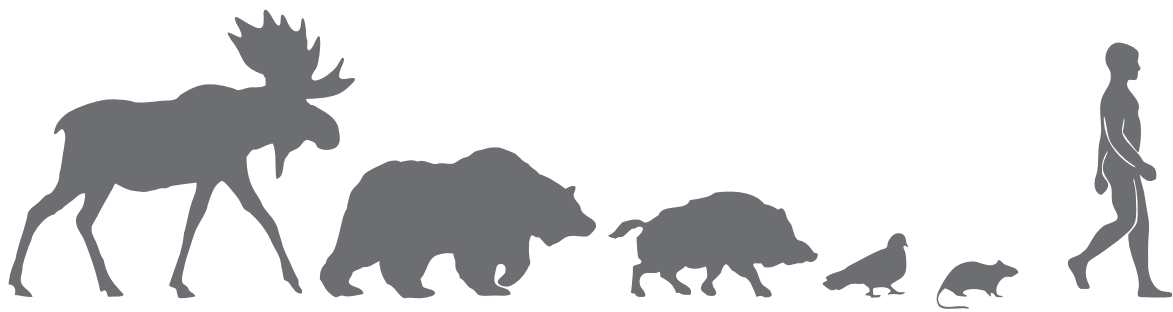
Anticoagulant rodenticides (AR) are commonly used for rodent pest control because their delayed mode of action prevents bait shyness of the target species, and because an antidote is available (vitamin K). In addition to target species like house mice (*Mus musculus*) and Norway rats (*Rattus norvegicus*) non-target small mammals also consume bait (primary poisoning) and have the potential to pass it on to predators (secondary poisoning). Because little is known about the relative importance of primary and secondary poisoning with ARs, we screened for all 8 ARs registered in Germany in non-target small mammals as well as in red foxes (*Vulpes vulpes*) by HPLC-MS. We conducted a monitoring study, where small mammals were snap-trapped before, during and after a biocidal brodifacoum application in north-western Germany. Samples were taken twice a year in different distances from baiting points. Preliminary results show that brodifacoum liver residues mainly occurred close to the farm. In about 45% of 149 individuals trapped close to farms during and after the commencement of baiting we found brodifacoum residues. *Apodemus* mice were more affected than voles. Unexpectedly, we regularly found residues in shrews. Until now regional fox screening identified at least one AR in 61% of 160 fox liver samples with brodifacoum found most often. Results demonstrate that primary poisoning with ARs in small non-target mammals is restricted to areas close to farms and to particular species while secondary poisoning of foxes is common. (funded by German Federal Environment Agency grant #371063401).

Ecologically Based Pest Management

Oral presentations

Monday 23rd September 2013, Pharma 1

- 14:00–14:20 **O7.** Prospects for ecologically-based management of rodent population outbreaks: can we mitigate 50-year cyclic famine in South Asia? *Steven Belmain*
- 14:20–14:40 **O8.** A multi-country experiment of rat and weed interactions in Asia: ecological studies assist our quest for increased future food security, *Grant Singleton*
- 14:40–15:00 **O9.** Do wolves (*Canis lupus*) help protect forest regeneration from ungulates? *Zbigniew Borowski*
- 15:00–15:30 COFFEE
- 15:30–15:50 **O10.** Ecological applications of airborne laser scanning – analyzing habitat preferences and behavior of moose (*Alces alces*), *Markus Melin*
- 15:50–16:10 **O11.** VECMAP, a one-stop-shop for vector mapping, *Guy Hendrickx*



07. Prospects for ecologically-based management of rodent population outbreaks: can we mitigate 50-year cyclic famine in South Asia?

Steven Belmain¹, Nikhil Chakma^{2,3}, Noor Jahan Sarker², Sohrab Sarker², Nazira Kamal³, Santosh Sarker³

¹Natural Resources Institute, University of Greenwich, Chatham Maritime, UK, ²Department of Zoology, Dhaka University, Dhaka, Bangladesh, ³Association for Integrated Development-Comilla, Raghupur, Comilla Sadar, Bangladesh

Rodent population outbreaks occur in many parts of the world in response to changes in food abundance where biotic, abiotic and human activity can lead to prolonged duration of food availability as well as increased quantity. Semelparous bamboo (*Melocanna baccifera*) masting in South Asia, occurs on a 50-year cycle and ultimately leads to rodent population outbreaks with historic accounts of regional famine and civil war. The most recent masting event, which began in 2004 in the northernmost part of its range (Manipur State, India) and ended in 2010 (southern Chittagong, Bangladesh and Chin State, Myanmar), resulted in approximately 80 tonnes per hectare of bamboo seed per annum, fuelling rodent breeding over 7–8 months preceding the rice harvest period. Our research in the Chittagong Hill Tracts of Bangladesh provides evidence about the linkage between bamboo masting and rodent breeding and that natural variation in the timing of bamboo seed onset can influence the duration of rodent breeding and the potential for rodent outbreaks to emerge at the local scale. Manipulative trials involving burning and cutting bamboo culms were shown to significantly delay seed development and could be used to sufficiently shorten the rodent breeding period and/or delay outbreaks until after rice crops are normally harvested. Farmer practices of planting early ripening varieties of rice during outbreak years and using rat barrier fences around their rice fields can also help mitigate the impact of rodent outbreaks, particularly if further research can integrate their practice into an EBRM strategy.

08.A multi-country experiment of rat and weed interactions in Asia: ecological studies assist our quest for increased future food security

Grant Singleton¹, Niamh Quinn¹, Nyo Me Htwe², Ibu Rachmawati³, David Johnson¹

¹International Rice Research Institute, Los Banos, The Philippines, ²Department of Agriculture, Yangon, Myanmar, ³Indonesian Center for Rice Research, Sukamandi, Indonesia

In Asia, rodents and weeds are two of the main constraints to rice production, where pre-harvest losses by rodents are 5–10%, and by weeds 10–20%. Smallholder farmers rank them similarly because although weed management may require considerable labour at least they can generally manage the problem, whereas rodent management is more problematic. Moreover, occasional outbreaks of rodent populations can lead to severe crop losses and major food shortages. Precious little is known of the interaction between rodents and weeds in rice systems. We hypothesise: (i) high rodent densities result in a high number of cut tillers that opens the canopy and benefits weeds; (ii) high weed infestations in and around crops provide high protein seeds that benefit rodent populations, particularly when rice is at vegetative stage. We conducted replicated (4), manipulated treatments in the fields of farmers (0.25 ha per treatment): no weeds + rats; no weeds + no rats; weeds + rats; weeds plus no rats. The study was duplicated in Laguna, Philippines, South Sumatra, Indonesia, and Bago, Myanmar. We will report on preliminary findings from 1 dry and 1 monsoon crop. At Telang delta in South Sumatra, the density of rodents and weeds were so high during the dry season crop that our study design was compromised. This occurrence underlines the imperative for the ecology of rodent and weed communities to be managed at a landscape level to help alleviate losses for the 4.1 billion people that rely on rice as their food staple.

09. Do wolves (*Canis lupus*) help protect forest regeneration from ungulates?

Zbigniew Borowski, Marek Pudelko
Forest Research Institute, Raszyn, Poland

Large predators can both directly and indirectly influence ungulate populations and as a consequence help shape the structure and functioning of terrestrial ecosystems. In Europe ungulates create the biggest problem for forest regeneration, whereas the wolf is known to be a species creating density-mediated and behaviourally-mediated effects on their ungulate prey species. We analysed the role of wolf presence on the level of damages caused by ungulates in young forest stages on a national level. 116 forest districts located in different parts of Poland were chosen for this analysis. These forest districts were divided into three categories: (1) districts where wolves were present at least from the year 2000, (2) where they were present from 2005, (3) districts without wolf presence. The impacts of ungulate populations on forest ecosystem were calculated as area and intensity of trees damaged by deer species. Generally, in forest districts where wolves were present the ungulate pressure on young forest stages is significantly lower than in districts without this predator. The lowest damaged areas with lowest damage intensity were observed in locations where wolves had been present for at least 12 years. However, in forests recently inhabited by wolves the intensity of tree damage was similar (in forest cultures) or higher (in thickets) than in forests without wolves. Our results indicate that long-lasting presence of large predators, such as wolf, in European forest ecosystems has a positive impact on forest regeneration, because their presence helps protect commercial forests against deer browsing and bark stripping.

10. Ecological applications of airborne laser scanning – analyzing habitat preferences and behavior of moose (*Alces alces*)

Markus Melin¹, Petteri Packalen¹, Lauri Mehtätalo¹, Juho Matala², Olli-Pekka Tikkanen¹, Raisa Tiilikainen⁴, Matti Maltamo¹, Jyrki Pusenius³

¹University of Eastern Finland, Joensuu, Finland, ²Finnish Forest Research Institute, Joensuu, Finland, ³Finnish Game and Fisheries Research Institute, Joensuu, Finland, ⁴Finnish Game and Fisheries Research Institute, Helsinki, Finland

Widely used in forestry, ALS (airborne laser scanning) enables detailed three dimensional (3D) descriptions of forests and their vegetation. Simultaneously, ecologists have recognized that 3D vegetation structure is highly important in analysing the habitat suitability of a given site. In our studies, we extracted ALS data from locations gained from GPS-collared moose. In our first study, we investigated how habitat structure changed as a function of distance to observed moose locations and how observed moose locations differ from randomly selected locations in terms of 3D structure. The results suggested that there are clear differences between these areas and that this can be detected from ALS data. In the second study, we focused on the effect of high summer temperatures on moose behaviour. The results provided us detailed information about the relationships between moose and the structure of forests it used in different thermal conditions. We then discovered that as daily temperatures began to reach 20°C and higher, the areas with higher and denser canopies during daytime became favoured. More importantly, the two studies gave support for the use of ALS in analysing animal behaviour and/or habitat use. Forests are scanned with ALS in growing numbers and our methods are applicable for other species as well. By extracting ALS data from a species' habitat, a lot can be learned about 1) its behaviour and habitat use and 2) about its relationships with and possible effects on the surrounding environment. This all makes ALS a tool worth studying.

11. VECMAP, a one-stop-shop for vector mapping

Guy Hendrickx¹, William Wint², Laurent Braak³, Els Ducheyne¹, Davide Coppola⁴, Veerle Versteirt¹

¹Avia-GIS, Zoersel, Belgium, ²ERGO, Oxford, UK, ³MEDES, Toulouse, France, ⁴ESA-ESTEC, Noordwijk, The Netherlands

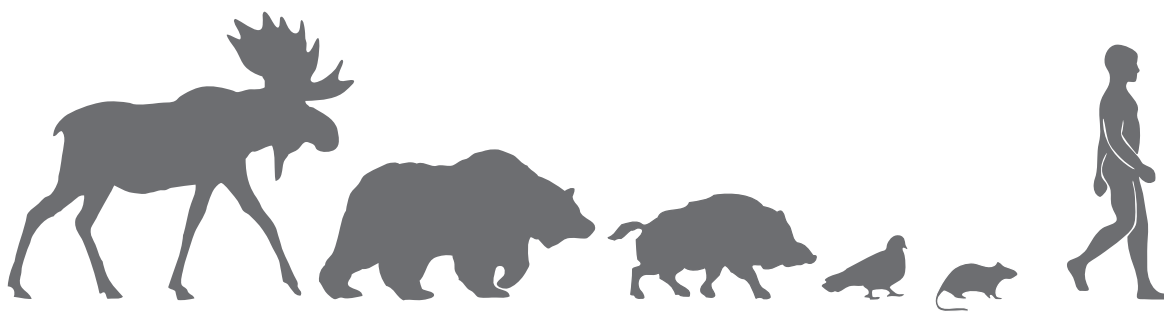
Diseases carried by vectors are an increasing concern worldwide, yet often relatively little is known about their spatial distribution. Without a clear understanding of where the diseases or vectors are already present or which areas are vulnerable to spread, effective strategic planning for control in the event of an outbreak is impossible. VECMAP is the first tool which addresses this problem head on by providing a seamless system that integrates the entire process of producing risk maps into a single package that can be used by a wide range of practitioners. The VECMAP system is developed with support from the European Space Agency (ESA) and includes three main components. The first provides the means to design and execute field sampling campaigns using smartphone and GPS technology linked to centralized databases. The second is an area-wide distribution modelling software package, fed by the VECMAP field samples and Earth Observation processed data. The third is the GIS which is the glue that integrates the other components and provides access to all the required supporting data as well as the means to display and analyse final mapped products. In this presentation the user driven approach adopted to develop the system is described: from user needs to system requirements and system architecture and an overview is given of the system and of the demonstration activities by 12 independent research and public health teams in 9 countries in Europe and Africa.

Chemical Control – Methods and Alternatives

Oral presentations

Monday 23rd September 2013, Pharma 2

- 09:30–09:50 **O12.** Development of a bird repellent: screening of plant extractions, *Joanna Dürger*
- 09:50–10:10 **O13.** Are cafeteria experiments with free ranging animals a useful tool for repellent testing? *Juho Matala*
- 10:10–10:40 COFFEE
- 10:40–11:00 **O14.** Rodenticide developments and new delivery systems, *Charles Eason*
- 11:00–11:20 **O15.** Genetic distance of Norway rats (*Rattus norvegicus*) on a local scale in the Y139C-resistance area in Westphalia, Germany, *Alexandra Esther*
- 11:20–11:40 **O16.** Mutations of the VKORC1 gene in Norway rats (*Rattus norvegicus*) – locating and delimiting anticoagulant resistance foci in South East England, *David Rymer*
- 11:40–12:00 **O17.** Assessment of resistance factors to second generation anticoagulant rodenticides by BCR-tests in the homozygous anticoagulant resistant strains Y139C and Y139F of the Norway rat, *Stefan Endepols*
- 12:00–13:00 LUNCH
- 14:00–14:20 **O18.** Vitamin K requirement of two VKORC1 resistant Norway rat (*Rattus norvegicus*) strains common in Belgium: Y139F and L120Q, *Kristof Baert*
- 14:20–14:40 **O19.** Target Resistance to VKA – Part 1 – An overview about the catalytic mechanism of VKORC1 enzyme, *Etienne Benoit*
- 14:40–15:00 **O20.** Target Resistance to VKA – Part 2 – An overview about the catalytic consequences of VKORC1 mutations, *Etienne Benoit*
- 15:00–15:30 COFFEE
- 15:30–15:50 **O21.** Resistance to Vitamin K antagonists. Two phenotypes for one rVKORC1 mutation (L120Q mutation), *Virginie Lattard*
- 15:50–16:10 **O22.** Consequences of spontaneous mVKORC1 mutations on the resistance phenotype, *Joffrey Goulois*
- 16:10–16:30 **O23.** Linking predator exposure and patterns of treatments with anticoagulant rodenticides by using faeces, *Marion Jacquot*
- 16:30–16:50 **O24.** Stewardship of anticoagulant rodenticides in the United Kingdom and in Ireland, *Colin Prescott*



O12. Development of a bird repellent: screening of plant extractions

Joanna Dürger¹, Michael Diehm², Karl Neuberger², Ralf Tilcher³, Alexandra Esther¹

¹Julius Kühn-Institute, Federal Research Centre for Cultivated Plants, Institute for Plant Protection in Horticulture and Forests, Vertebrate Research, Münster, Germany, ²PhytoPlan Diehm & Neuberger GmbH, Heidelberg, Germany, ³KWS SAAT AG, Einbeck, Germany

Birds damage seeds and seedlings and cause substantial harvest and income losses in organic farming. Otherwise, there are unintentional intoxications of birds if they consume toxic baits, which are used for managing other species. The measure to avoid bird feeding could be a repellent. Our project's aim is to develop such a bird repellent consisting of toxicologically harmless substances extracted from plants. The first step is a systematic screening of various plant extractions used as treatment of corn seeds. Plant extractions with strong repellent effects on pigeons and pheasants could be identified in aviaries by multiple- and two-choice experiments. Seedling and field experiments with the best substances are still on going. Results of the screening of plant extractions will be presented and consequences will be discussed. The project is funded by the Federal Ministry of food, agriculture and consumer protection decided by the German Bundestag.

O13. Are cafeteria experiments with free ranging animals a useful tool for repellent testing?

Juho Matala¹, Jarkko Tuononen²

¹Finnish Forest Research Institute, Joensuu, Finland, ²Metsähallitus, Lieksa, Finland

Effective repellents are practical tools for protecting tree seedlings from vertebrate pests at small problem areas. To attain official permission for use in Finland, the effectiveness of these products is tested with field trials which in ideal cases are easy to perform but also provide generalizable results. To find out a testing method with low effort and costs, we set up a trial where we tried to use free ranging moose (*Alces alces*) in a cafeteria -type experiment setting to test repellent efficiency in winter. We had two study sites in known winter areas of moose in western and eastern parts of central Finland. In one site there was complementary feeding with fresh hay in AIV-solution available along with salt stones, whereas in another site there were only salt stones to attract moose to the trial. In both sites, we set up feeding stations at which rowan (*Sorbus aucuparia*) and aspen (*Populus tremula*) seedlings treated with 3 repellent products were provided to moose along with untreated control seedlings. During the trial, sites were visited by 5 and 12 moose individuals and 1 and 3 hare (*Lepus timidus*) individuals whose visits were documented with game cameras and their feeding was measured with an interval of 1 to 2 weeks. Control seedlings had more moose bites than repellent treated ones but total browsing by moose was too low to gain generalizable results. Increased attraction directly to feeding stations would be needed to improve success of cafeteria method with free animals.

O14. Rodenticide developments and new delivery systems

Charles Eason^{1,2}, Elaine Murphy^{2,3}, Lee Shapiro⁴, Duncan MacMorran⁴, Helen Blackie²

¹Cawthron Institute, Nelson, New Zealand, ²Lincoln University, Canterbury, New Zealand, ³Department of Conservation, Christchurch, New Zealand, ⁴Connovation Ltd, Auckland, New Zealand

In this presentation I will provide an update on rodenticide research in New Zealand and review the registration status of rodenticides. Anticoagulant compounds, and in particular brodifacoum plays an important role in the control of rodents and other pests. However, there are concerns regarding the persistence of some compounds and resistance. We believe it is important to retain and refine the use of both anticoagulant and non-anticoagulant rodenticides and explore new compounds. In 2011 para aminopropiophenone (PAPP), a methaemoglobinaemia inducer which does not bioaccumulate and has an antidote was registered for the control of predators. Zinc phosphide was recently registered for the first time and a low dose of cholecalciferol combined with coumatetralyl is being pursued. Data from trials with conventional baits and from trials with resettable, long-life, toxin delivery systems will be presented. These resetting systems will enable long-term suppression of pest populations.

O15. Genetic distance of Norway rats (*Rattus norvegicus*) on a local scale in the Y139C-resistance area in Westphalia, Germany

Alexandra Esther¹, Nicole Klemann², Ilona Krämer³, Stefan Endepols⁴, Dagmar Funck¹, Susanne Theuer⁵, Anke Broll¹, Stephan König⁶

¹Julius Kuehn-Institute (JKI), Federal Research Centre for Cultivated Plants, Institute for Plant Protection in Horticulture and Forests, Vertebrate Research, Münster, Germany, ²Spillenweg 3, Warendorf, Germany, ³JKI, Institute for Resistance Research and Stress Tolerance, Quedlinburg, Germany, ⁴Bayer CropScience AG – Environmental Science, Monheim, Germany, ⁵Leibniz-Institute for Agricultural Engineering, Potsdam, Germany, ⁶JKI, Institute for Plant Protection in Horticulture and Forests, Braunschweig, Germany

The Westphalian resistant strain of *Rattus norvegicus* is indicated by the Y139C single nucleotide polymorphism of the *vkorc1* gene, which leads to practical resistance against the anticoagulants warfarin, coumatetralyl, bromadiolone and difenacoum. Farms with rat control problems seemed to be hot spots of resistance and origins of resistance spread. However, first results of our spatial study showed no correlation between the resistance gene frequency and the distance to an assumed resistance gene hot spot. Within each rat population along a 12 km gradient the Y139C polymorphism occurred with internal population frequencies between 20% and 80%. Beside management deficits intensive exchange between the populations by dispersal could be the reason. However dispersal processes and resulting genetic distance between natural populations in the cultural prone area of Westphalia is completely unknown, and needs further investigation for management suggestions. Therefore, in the second study part we disentangled resistance gene occurrence and rat migration along the spatial gradient by a genetic distance analysis of the rat community using a set of nine *R. norvegicus* specific microsatellite markers. Dynamics and spatial structure of the rat populations will be presented and possible mechanisms of the resistance spread in coherence to the individual genetic distance within the populations will be discussed.

O16. Mutations of the VKORC1 gene in Norway rats (*Rattus norvegicus*) – locating and delimiting anticoagulant resistance foci in South East England

David Rymer, Alan Buckle, Mhairi Stevens, Colin Prescott
University of Reading, Reading, UK

Historically, alleged practical resistance to anticoagulants in rodents (indicated by the inability to control a population through use of anticoagulant rodenticides) has been found in almost all of the counties of the South East of England. The advance of molecular techniques in the last decade has allowed the confirmation of historical data through identification of single nucleotide polymorphisms (SNPs) in the VKORC1 gene of various species. Tissue samples from Norway rats (*Rattus norvegicus*) from across South East England were taken and DNA from the VKORC1 gene sequenced in order to identify the resistance mutations present. A GIS was created to display data points and thereby delimit individual resistance foci. Results indicate a previously unsuspected level of L120Q and Y139F resistance spread across extensive areas tested. These data allow pest controllers and landowners to take a more informed approach to rodent control and potentially reduce the risk of selecting for resistant animals through the application of ineffective rodenticides.

O17. Assessment of resistance factors to second generation anticoagulant rodenticides by BCR-tests in the homozygous anticoagulant resistant strains Y139C and Y139F of the Norway rat

Stefan Endepols¹, Alexandra Esther²

¹Bayer CropScience AG, Monheim, Germany, ²Julius-Kühn-Institute, Münster, Germany

Five polymorphisms in the *vkorc1* gene are linked to tolerance to anticoagulant rodenticides at different levels in the Norway rat. The VKOR polymorphisms Y139C and Y139F appear in several foci of resistance in Europe, such as in France, Germany, the UK and Denmark. The level of resistance to second generation anticoagulant rodenticides (SGARs) should be determined therefore in these strains in order to recommend control strategies in the respective foci of resistance. A standardised blood clotting response test was performed with males and females of the homozygous Y139F and Y139C laboratory strains of the Norway rat in order to determine dose-response relations for all SGARs. The rats received the SGARs at certain multiples of the ED50 of the baseline susceptible strain. The ED50 and the respective resistance factor were calculated for each compound in both strains. Considerable levels of tolerance were found for bromadiolone and difenacoum in both strains. Brodifacoum, difethialone and flocoumafen remain effective substances to combat rat infestations of both rat strains. The study was funded by the Rodenticide Resistance Action Committee (RRAC) of CropLife International.

O18. Vitamin K requirement of two VKORC1 resistant Norway rat (*Rattus norvegicus*) strains common in Belgium: Y139F and L120Q

Kristof Baert, Jan Stuyck

Research Institute for Nature and Forest (INBO), Brussels, Belgium

Vitamin K is an essential co-factor in the activation of several coagulation factors and plays an important role in blood coagulation. Resistance against anticoagulant rodenticides is based on a single nucleotide polymorphism in the VKORC1 gene. A pleiotropic effect of rodenticide resistance is an increased need for vitamin K. Therefore we tested homozygous resistant rats (Y139F, L120Q) for their vitamin K requirement by feeding six males and six females of each strain with a vitamin K deficient diet (Altromin) for two weeks, yet coprophagy was not prevented. Then on days 0, 3, 5, 7, 10 and 14 of the experiment prothrombin time (PT) was measured and expressed as international normalized ratio (INR). Rats with an INR > 5 were considered responders. Three L120Q-males showed a slightly increased PT (INR > 2) on day 0, while five L120Q-males reached an INR > 5 (1/day 3, 2/day 5, 1/day 10 and 1/day 14). Within the group of the L120Q-females two rats responded to the treatment respectively on day 10 and 14, and one rat died on day 7 without bleeding signs. One Y139F-male showed an INR > 5 on day 7 and two Y139F-females died on day 10 with signs of severe anaemia and so considered as responders. None of the Y139F-females reached an INR > 5. According to this preliminary study the L120Q-strain is more sensitive to vitamin K deprivation than the Y139F-strain. Although both strains showed a prolonged clotting time compared to warfarin susceptible strains, it remains unclear as to what degree vitamin K deficiency occurs in the field and could affect the relative fitness of resistant rats.

O19. Target Resistance to VKA – Part I – An overview about the catalytic mechanism of VKORC1 enzyme

Etienne Benoit, Virginie Lattard

USC 1233 INRA-VetagroSup, Marcy l'étoile, France

The VKORC1 gene has been described in 2004 by the groups of Oldenburg and Stafford. Since then, many mutations have been described and linked to resistance to VKAs either in humans or in rodents. In rodents, the involvement of a target resistance, i.e. due to mutations of the VKORC1 gene seems to be extremely frequent in the western part of Europe. Nevertheless, a lot of aspects concerning the VKORC1 enzyme remain quite unknown. The mechanism of action of this enzyme remains quite unclear, and the interaction with VKAs is not understood. The different aspects of this enzyme will be presented and discussed.

O20. Target Resistance to VKA – Part 2 – An overview about the catalytic consequences of VKORC1 mutations

Etienne Benoit, Virginie Lattard

USC 1233 INRA-VetagroSup, Marcy l'étoile, France

The VKORC1 gene has been described in 2004 by the groups of Oldenburg and Stafford. Since then, many mutations have been described and linked to resistance to VKAs either in humans or in rodents. In rodents, the involvement of a target resistance, i.e. due to mutations of the VKORC1 gene seems to be extremely frequent in the western part of Europe. Nevertheless, a lot of aspects concerning the VKORC1 enzyme remain quite unknown. The catalytic consequences of the different spontaneous mutations observed in resistant humans and rodents are described using different heterologous expressions systems or using liver microsomes, sometimes leading to non-coherent results. The different aspects of this enzyme will be discussed, focusing on the relation between genotype and phenotype.

O21. Resistance to Vitamin K antagonists. Two phenotypes for one rVKORC1 mutation (L120Q mutation)

Maylis Boitet, Benoit Rannou, Stéphane Besse, Bernadette Espana, Arnaud Michaux, Etienne Benoit, Virginie Lattard

USC 1233 INRA-VetagroSup, Marcy l'étoile, France

Berkshire rats were described as highly resistant to VKAs. A mutation in the VKORC1 gene was described in this strain and corresponds to an L120Q amino acid substitution. In our laboratory we cross-bred Berkshire rats with laboratory SD rats in order to introgress the L120Q mutation in the genetic background of the SD rats. After 6 generations of backcrossing we bred heterozygous F7 rats in order to obtain a quasi congenic strain homozygous for the L120Q mutation. The resistance to VKAs bromadiolone, difenacoum and brodifacoum of these rats was compared to the resistance of the original Berkshire strain. While the L120Q mutation was homozygous in all animals assayed, the VKA effects were quite different. The resistance to VKAs, particularly to bromadiolone and difenacoum, was observed in all animals. However, resistance was greater in the Berkshire strain, and more so in females than in males. The liver concentration of VKAs did not exhibit major difference in these two strains. These results argue for another mechanism independent of VKORC1 and independent from the metabolism of VKAs being involved in the resistance of the Berkshire strain.

O22. Consequences of spontaneous mVKORC1 mutations on the resistance phenotype

Joffrey Goulois, Abdesslem Hamed, Etienne Benoit, Virginie Lattard
USC 1233 INRA-VetagroSup, Marcy l'étoile, France

Vitamin K Antagonists (VKAs) are commonly used as rodenticide to manage rodent populations. VKAs target blood coagulation by inhibiting the vitamin K epoxide reductase which is encoded by the VKORC1 gene. The inhibition of VKORC1 enzyme limits the availability of vitamin K hydroquinone which is necessary for the synthesis of vitamin K dependent blood clotting factors. In rats and humans, several mutations in the VKORC1 gene lead to resistance to VKAs. Nevertheless, some other spontaneous human VKORC1 mutations apparently do not modify the catalytic properties of the corresponding protein while some other spontaneous mutations apparently inactivate the enzyme. In mice, different mutations in the mVKORC1 gene have been described. A group of 4 mutations was also found in *Mus musculus domesticus*. These 4 mutations correspond to the VKORC1 gene found in *Mus spretus*. The aim of this study is to investigate the catalytic consequences of the mutations spontaneously observed in the mice and to evaluate the causality of these mutations in the resistant phenotype. This goal is achieved by the heterologous expression of mVKORC1 and the corresponding mutants (Leu 128 Ser, Tyr 139 Cys, Arg 58 Gly, Leu 59 Trp, Leu 124 Gln and the *spretus* group of mutations) in *Pichia pastoris* and the determination of the kinetic parameters (V_m and K_m) and the inhibition constant (K_i) when different VKAs are used. Results show that some mutations lead to severe resistance and that the mVKORC1 containing the four *spretus* mutations corresponds to an enzyme extremely resistant to VKA enzyme.

O23. Linking predator exposure and patterns of treatments with anticoagulant rodenticides by using faeces

Marion Jacquot¹, Michael Coeurdassier¹, Mickael Sage^{1,5}, Isabelle Fourel², Anke Dinkel⁴, Anne-Laure Parmentier¹, Antoine Dervaux¹, Dominique Rieffel¹, Yves Prat-Mairet¹, Francis Raoul¹, Patrick Giraudoux^{1,3}

¹Department Chrono-Environnement UMR 6249 University of Franche-Comté/CNRS Usc INRA, Besançon, France, ²BIOLYTICS Institut Claude Bourgelat VetAgro Sup, Marcy l'Etoile, France, ³Institut Universitaire de France, Paris, France, ⁴University of Hohenheim Department of Parasitology, Stuttgart, Germany, ⁵Wildlife – Environment – Expertises, Besançon, France

Rodent predators are largely exposed to anticoagulant rodenticides (AR). To mitigate their exposure, drivers of transfer should be better characterized. The measurement of AR residues in faeces appears a potential non-invasive indicator to assess the exposure of vole predators. However, it is unknown whether AR residues in faeces are correlated with treatment patterns. In 2011, fox-like faeces were sampled in 2 contexts of AR usage, “plant protection product (PPP)/biocide” or “biocide only”. PPP treatments using bromadiolone were carried out to control water vole *Arvicola terrestris* populations. PPP treatments were quantified and geographically determined. In each usage category, 160 faeces of vole predators were geo-referenced and then stored at 20°C for further AR titration (LC-ESI/MS/MS) and species identification (DNA-PCR). DNA was successfully amplified for 37.2% of faeces. Among them, the most frequent species were the red fox (73.9%), cat (21.8%) and dog (4.2%). AR occurrence did not differ between fox, cat and PCR unidentified faeces ($p=0.35$). Every positive faeces contained only bromadiolone except one (biocide context) with chlorophacinone. ARs were detected more frequently where PPP treatments occurred ($p<0.001$). In PPP/biocide context, the ratio of positive faeces varied non-linearly with the area of PPP treatments within a 1km-radius around faeces ($p<0.001$; pseudo- $r^2=0.43$). It increased exponentially up to 70% until a treated area of 0.4 km². Thereafter the ratio increased almost linearly to 90% up to a treated area of 0.85 km². These results indicate that faeces collected in situ may be a relevant non-invasive target to monitor AR exposure comparatively.

O24. Stewardship of anticoagulant rodenticides in the United Kingdom and in Ireland

Alan Buckle, Colin V. Prescott
University of Reading, Reading, UK

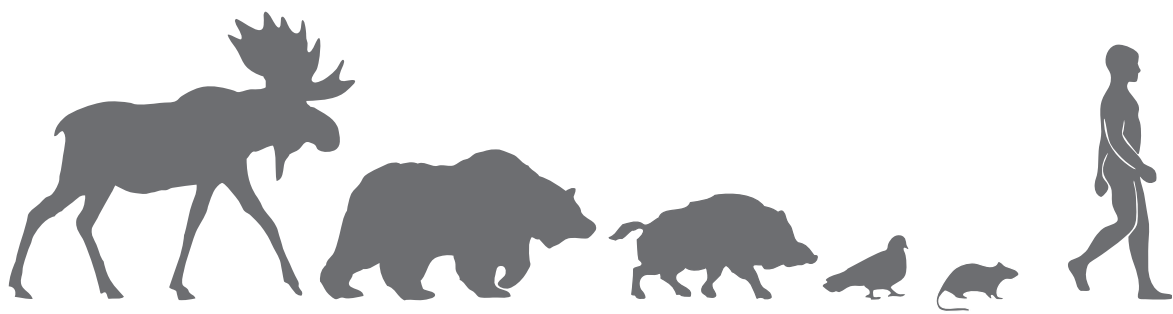
The introduction of the anticoagulant rodenticides in the 1950s was a significant advance for the safety and effectiveness of rodent control. It has long been understood, however, that their mode of action resulted in potential risks to non-target animals, especially mammals and birds. Fundamental risk mitigation measures, such as placing baits out of reach of non-targets, have always been implemented and successfully restrict exposure. However, it was increasingly recognised after research conducted in the UK that, in spite of such measures, there was considerable exposure of wildlife to anticoagulants, in particular to the most widely-used second-generation compounds. At first, secondary exposure via consumption of target rodents was thought to be responsible. Later, study of the diets of exposed species led to the conclusion that most exposure was probably caused by consumption of non-target small mammals, such as wood mice (*Apodemus sylvaticus*) and voles (*Microtus agrestis* and *Myodes glareolus*). Different mitigation approaches are required to prevent such exposure. In light of this, the regulatory authorities in the United Kingdom and in Ireland have requested programmes of stewardship aimed at all rodenticide users to promote risk mitigation to prevent wildlife exposure. The rodenticide industry has therefore initiated the Campaign for Responsible Rodenticide Use (CRRU). The main objective of CRRU is to make users aware of wildlife exposure to rodenticides, the routes through which exposure occurs and the measures to apply to prevent it. A wide range of methods, including training and mass media, is used to communicate this information to users.

Invasive Vertebrates

Oral presentations

Tuesday 24th September 2013, Pharma 1

- 09:30–09:50 **O25.** The impact of ranch escapee American mink on feral populations,
Agnieszka Niemczynowicz
- 09:50–10:10 **O26.** Eradication of American mink in the Finnish archipelago – a success story,
Mikael Nordström
- 10:10–10:40 COFFEE
- 10:40–11:00 **O27.** Eradication of invasive mammals on islands – factors predicting success,
Andrea Zanetta
- 11:00–11:20 **O28.** Adaptive management of invasive Norway rats (*Rattus norvegicus*) on the Calf of Man to conserve Manx shearwaters (*Puffinus puffinus*), *Mark Lambert*
- 11:20–11:40 **O29.** Eradications as scientific experiments: first attempt to eradicate two major invasive taxa, *Rattus rattus* and *Carpobrotus* spp. from a Mediterranean island,
Lise Ruffino
- 11:40–12:00 **O30.** Eradication of rodents and rabbits from sub-Antarctic Macquarie Island,
Keith Springer
- 12:00–13:00 LUNCH
- 14:00–14:20 **O31.** The role of Norway rat (*Rattus norvegicus*) predation in determining breeding success of Manx shearwaters (*Puffinus puffinus*) on the Scottish island of Rùm,
Mark Lambert
- 14:20–14:40 **O32.** Vertebrate pest management initiatives in the Southern Ocean,
Keith Springer
- 14:40–15:00 **O33.** RHD-Boost – strengthening rabbit control in Australia, *Glen Saunders*
- 15:00–15:30 COFFEE
- 15:30–15:50 **O34.** Ponto-Caspian gobies in Switzerland – science meets management,
Irene Kalchauer
- 15:50–16:10 **O35.** Applied research as a basis for sustainable management of non-native gobies,
Patricia Burkhardt-Holm
- 16:10–16:30 **O36.** Estimating the risks related to non-native fish species – first application of FISK, the Freshwater Fish Invasiveness Screening Kit, in Southern Finland,
Riikka Puntila



O25. The impact of ranch escapee American mink on feral populations

Agnieszka Niemczynowicz¹, Marcin Brzeziński², Andrzej Zalewski¹

¹Mammal Research Institute Polish Academy of Science, Białowieża, Poland, ²Faculty of Biology, University of Warsaw, Warsaw, Poland

The invasion of ecosystems by introduced non-native species provides an excellent opportunity to study adaptation and evolutionary processes over relatively short timescales. In our study we compared the structure of populations (density, body size and age structure) between two regions of Poland. Western Poland is characterized by high numbers of ranch mink with high numbers of escapees, whereas eastern Poland is characterized by low numbers of ranches with few mink escapees. The American mink removal programme was conducted in four national parks in Poland (Narew and Biebrza - eastern Poland; Warta Mouth and Drawa - western Poland). At each study site there was one removal area (where mink were removed) and one control area (where mink were marked and released). Genetics and stable isotopes analyses were used to divide all mink into two groups: 1) ranch mink escapees and 2) feral mink. Genetic analyses have shown that there are three times more ranch mink escapees in western Poland than in the East. Feral mink from West Poland were larger than mink from East Poland, which could be a result of the impact of escapees from ranches. The lowest mean index of mink density was recorded in the western national park. In the western national parks the age structure was more dominated by juvenile individuals than in the eastern national parks (almost 80% and 57% respectively). In the West, the mortality rate is very high because only about 10% of individuals survived the first month.

O26. Eradication of American mink in the Finnish archipelago – a success story

Mikael Nordström¹, Päivi Salo³, Tommy Arfman⁵, Jouko Högmänder¹, Jukka Nummelin⁵, Madeleine Nyman², Mikko Toivola⁴

¹Metsähallitus, Turku, Finland, ²Metsähallitus, Raseborg, Finland, ³University of Turku, Turku, Finland, ⁴Finnish Wildlife Agency, Kaarina, Finland, ⁵Private person (hunter), SW Finland, Finland

The American mink (*Mustela/Neovison vison*) was introduced to Finland as a fur animal in the 1920s. Escapees from fur farms soon established feral populations and by the 1980s mink had invaded the whole country, including the south-western archipelago. When the numbers of many seabird species typical of the outer archipelago started to decline, Metsähallitus (a state enterprise managing the Archipelago Sea National Park) launched a pilot project to remove mink from a group of islands in 1992. Hunters involved in the project utilized mostly a novel combination of dogs to locate mink and a leaf-blower to drive mink out from refugia under boulders, but spring traps were also used. The results were very encouraging as the number of removed mink declined within a couple of years from 30–40 mink/hunting season to 0–6 individuals per season. Mink removal was therefore extended to another island group in 1998 and even further in 2006, currently covering ca. 750 km² of sea with scattered small islands and islets in the outermost part of the Archipelago Sea. The experimental setup of mink removal and matching control areas has produced a lot of research about mink impacts on native fauna, showing that mink predation has a negative effect on many bird species, small mammals and common frogs in the archipelago. Mink eradication is thus an important conservation issue, and Metsähallitus is enhancing similar actions also in other bird protection areas along the Finnish coast.

O27. Eradication of invasive mammals on islands – factors predicting success

Andrea Zanetta, Sven Bacher

University of Fribourg, Fribourg, Canton of Fribourg, Switzerland

Invasive mammals on islands constitute a significant threat to global biodiversity. Numerous plant and animal species have gone extinct or face extinction due to the introduction of mammals on islands. To counter this issue and to ensure the survival of the native species conservation managers may opt to eradicate permanently the invasive species. Eradication campaigns are often overlooked as a conservation measure, although they are still a valid strategy. In this paper we aim to identify which factors are important to achieve a successful eradication. Several explanatory variables have been hypothesized to have an influence on the eradication success, such as species-specific traits, island characteristics and other information related to the individual campaign. For example, we hypothesize that small-sized species with high rates of reproduction are more difficult to eradicate. Furthermore, we predict that eradication campaigns on small islands are more likely to succeed than those on large islands. To test these hypotheses, we statistically analysed more than 1000 eradication campaigns reported in the Database of Island Invasive Species Eradications. The results indicate that large-sized species have been eradicated with higher success rates than small-sized species. The success rate increased throughout the years and we found evidence that using a combination of eradication methods improved the chance of success. The size of the island appears to not constitute a decisive factor. We conclude that the success of eradication is mainly dependent on the biology of the target species, on the commitment of managers and on the availability of resources.

O28. Adaptive management of invasive Norway rats (*Rattus norvegicus*) on the Calf of Man to conserve Manx shearwaters (*Puffinus puffinus*)

Mark Lambert¹, Duncan Bridges⁴, Robbie McDonald³, Richard Jamieson⁴, Claire Barnett⁵, Shaun Murphy², Will Hayward⁴, Richard Budgey¹, Jo Milborrow¹, Amy Campbell³, Kate Hawkins²

¹Animal Health and Veterinary Laboratories Agency, York, UK, ²Manx National Heritage, Douglas, Isle of Man, ³University of Exeter, Penryn, UK, ⁴Manx Wildlife Trust, Peel, Isle of Man, ⁵The Royal Society for the Protection of Birds, Belfast, Ireland

Through close association with human activity, commensal rodents have become widely and extensively distributed beyond their native range. Norway rats (*Rattus norvegicus*) have become almost ubiquitous, and introduced populations have been associated with declines and extinction of native fauna. There has been increasing interest in removing introduced rats to restore and protect native wildlife; several recent UK projects have focussed on the removal of rats to protect burrow-nesting seabirds, particularly petrels and shearwaters. In autumn 2012, we initiated a project to remove Norway rats from the Calf of Man, a 250 hectare island near the Isle of Man, to aid recovery of Manx shearwater (*Puffinus puffinus*) breeding colonies. Wax blocks containing the first-generation anticoagulant rodenticide coumatetralyl were dispensed from a 50m x 50m grid which included associated non-tidal sea stacks; 1,050 bait points in total. Rodenticides containing the second-generation anticoagulant bromadiolone were reserved for any areas where sustained bait takes or persistent signs of rodent activity were encountered. The majority of bait points (interior of the island) were checked every 2–3 days for 3 weeks then weekly until mid-December. The profile of bait takes, and reduction in activity signs, suggested that the majority of rats were removed by late November; further (monthly) bait checks were made until March 2013 when a two-year monitoring program was initiated. Long-term biosecurity measures will be necessary to mitigate the risk of Norway rat reintroduction, and systematic monitoring will aim to evaluate the impacts of the project on Manx shearwater populations and other native fauna.

O29. Eradications as scientific experiments: first attempt to eradicate two major invasive taxa, *Rattus rattus* and *Carpobrotus* spp. from a Mediterranean island

Lise Ruffino¹, Elise Krebs², Annie Aboucaya⁴, Laurence Affre², Alain Barcelo⁴, Nathalie Bigeard⁴, Lenka Brousset², Elise Buisson², Hélène Deméringo², Damien Fourcy³, Pascal Gillet⁴, Yannick Limousin⁴, Olivier Lorvelec³, Frédéric Médail², Jean-Yves Meunier², Michel Pascal³, Aurelie Passetti², Philippe Pone², François Rifflet⁴, Eric Vidal⁵

¹The University of Turku, Turku, Finland, ²Mediterranean Institute for Biodiversity and marine and continental Ecology (IMBE), UMR CNRS 7263/IRD 237/AMU, Aix-en-Provence, France, ³National Institute for Agronomic Research (INRA), UMR 0985 INRA, Rennes, France, ⁴Port-Cros National Park, Hyères, France, ⁵Mediterranean Institute for Biodiversity and marine and continental Ecology (IMBE), UMR CNRS 7263/IRD 237/AMU, Nouméa, New Caledonia

Black rats *Rattus rattus* and mat-forming iceplants *Carpobrotus* spp. are two major invasive taxa on Mediterranean islands. Their cumulative impacts on native flora and fauna disturb the functioning of island ecosystems and are of major concern for the preservation of rare native species. In 2010, a ten-year restoration project was launched by the National Park of Port-Cros, France, on the natural reserve of Bagaud Island (58ha), with the aim of eradicating, for the first time, both black rats and *Carpobrotus* spp. With the long-term monitoring of various native plants and animals, Bagaud Island will become a reference study site for scientific purposes and, eventually, a sanctuary for wildlife in the Mediterranean. The methods used to eradicate both taxa were adapted to the dense vegetation covering the island, and to the phenology and sensitivity of native species. A total of 1,921 rats were first removed by trapping, which allowed the use of a limited amount of poison (bromadiolone) in the second phase of the eradication. The removal of *Carpobrotus* spp. was conducted by manual uprooting of a total area of 19,000 m². Biosecurity measures have been set up to prevent any risk of reinvasion of both taxa. So far, no evidence of the presence of black rats has been observed on the island. The monitoring of native wildlife is currently conducted and the recovery of long-lived vulnerable species (e.g. shearwaters and petrels) is expected to be slow.

O30. Eradication of rodents and rabbits from sub-Antarctic Macquarie Island

Keith Springer

Tasmania Parks and Wildlife Service, Hobart, Tasmania, Australia

The presence of invasive vertebrate species on sub-Antarctic Macquarie Island has had devastating impacts on the island's flora, fauna and landforms. Previous eradication projects removed weka *Gallirallus australis* by 1989 and feral cats *Felis catus* by 2001. European rabbits *Oryctolagus cuniculus* have been subject to control efforts since the 1960s. Subsequent plans to eradicate rodents and rabbits recognised that the remaining pest species could be targeted simultaneously due to commonalities in eradication methodology. Funding of AUD\$24.7M was secured in 2007 for a multi-year project based on aerial baiting targeting rabbits and rodents, followed by hunting surviving rabbits with ground-based techniques. Planning commenced for a 2010 toxic bait application however this was abandoned due to shipping delays and poor weather. Concerns over non-target species mortality resulting from the limited baiting undertaken in 2010 led to renewed consideration of mitigation options. Rabbit Haemorrhagic Disease Virus (RHDV) was used in February 2011 to reduce the pre-baiting rabbit population and thus minimise toxic rabbit carcasses available to scavenging seabirds. Aerial baiting resumed in May 2011 and completed by July 2011. The rabbit hunting phase commenced in August 2011 using hunters and dogs and is on-going, with 13 rabbits located by December 2011. Rodent detection dogs are currently deployed to assist in determining rodent eradication success. No rodents have been detected post-baiting. The estimated rabbit population has been reduced from over 150,000 to undetectable levels. Two years after baiting vegetation recovery is already evident and increased burrow and surface nesting seabird activity has been observed.

O31. The role of Norway rat (*Rattus norvegicus*) predation in determining breeding success of Manx shearwaters (*Puffinus puffinus*) on the Scottish island of Rùm

Mark Lambert¹, Lesley Watt², Ian Cain³, Sean Carlisle⁴, Andy Douse⁵

¹Animal Health and Veterinary Laboratories Agency, York, UK, ²Scottish Natural Heritage, Isle of Rùm, UK, ³NBC Bird and Pest Solutions, Edinburgh, UK, ⁴Anglia Ruskin University, Cambridge, UK, ⁵Scottish Natural Heritage, Inverness, UK

Despite their association with declines of seabird populations, few studies have attempted to quantify the impacts of invasive rodents. In 2010 we initiated a removal study to determine the impact of introduced Norway rats on the breeding success of burrow-nesting Manx shearwaters on the Scottish island of Rùm. Three 28 hectare study areas were selected within the island's shearwater colonies which, unusually compared to other breeding populations of this species, occur at high (>500m) altitude. In year one, Norway rats were controlled in one (treated) area using anticoagulant rodenticides dispensed from a 30m x 30m grid of bait stations; rodent activity and shearwater productivity were assessed and compared with two non-treated (control) areas. The experiment was repeated in year two, in year three the treatment was switched to one of the previous control areas. Although differences in nest occupancy rates were found between areas, productivity did not significantly differ between treated and control areas. The level of rodent activity was low in all three years at all study sites. Although investigations continue, the present results suggest that some seabird colonies, because of their geography and isolation, may be less vulnerable to the effects of invasive Norway rats. This has important implications for the future management of invasive rodent populations, and may help to refine control strategies to make best use of limited resources. A recently initiated PhD project will aim to investigate the ecology of Norway rats on the island and their interactions with the globally-important Manx shearwater colonies.

O32. Vertebrate pest management initiatives in the Southern Ocean

Keith Springer

Tasmania Parks and Wildlife Service, Hobart, Tasmania, Australia

The Southern Ocean circles the globe in the land-scarce latitudes between 45° and 60° South, and encompasses the southern regions of the Pacific, Atlantic and Indian Oceans. Continental landmasses border or protrude only slightly into the Southern Ocean from Africa, South America and Australia. Islands dotted around the Southern Ocean form important breeding locations for sub-Antarctic and Antarctic wildlife species. The islands were heavily exploited for marine mammals during the 19th and 20th centuries, and vertebrates were introduced to the majority of sub-Antarctic islands either deliberately (usually for food) or accidentally. Many have become 'invasive' and have caused extensive environmental damage to island ecosystems, especially to native vegetation (from herbivores) and birdlife (from predators). On islands with both invasive herbivores and predators, impacts on flora and fauna are often exacerbated by interactions between them. Several countries have eradicated invasive vertebrates from islands they manage, including the United Kingdom, France, South Africa, Australia and New Zealand. Species targeted typically include rodents *Rattus* spp, *Mus musculus*, domestic cats *Felis catus*, European rabbits *Oryctolagus cuniculus* and ungulate species including goats *Capra hircus*, cattle *Bos taurus* and sheep *Ovis aries*. Current eradication projects are underway or planned on some sub-Antarctic islands including Macquarie, Gough, Marion, Antipodes and South Georgia. Previous operations on other islands have successfully removed invasive species, with resultant recovery of natural biota. Recent eradication successes demonstrate feasibility of increasingly complex operations and encourage further ambitious endeavours in the region, where many opportunities for vertebrate pest management remain.

O33. RHD-Boost – strengthening rabbit control in Australia

Glen Saunders¹, Brian Cooke², Tarnya Cox¹, Peter Kirkland³, Andrew Read³, Tanja Strive⁴

¹NSW Department Primary Industries, Orange, NSW, Australia, ²Invasive Animals CRC, Canberra, Australia, ³NSW Department Primary Industries, Menangle, NSW, Australia, ⁴CSIRO Ecosystems Sciences, Canberra, Australia

The economic benefits to Australia of biological controls for rabbits (first myxomatosis and then Rabbit Haemorrhagic Disease (RHD)) have been enormous. There is growing evidence that rabbits are now developing resistance to the originally released strain of RHD (RHDV CZ 351). The aim of the RHD-Boost project is to identify new RHDV strains with high lethality to rabbits resistant to infection with the current strain, and to rabbits infected with the endemic Australian Rabbit Calicivirus, RCV-A1, which offers partial immunity to lethal infection. The project is screening new candidate RHDV strains from Europe and Asia which are out-competing the original RHDV strains in the field, and strongly suppressing wild rabbit populations in cooler, wetter regions. Research will also be undertaken to confirm the competitive advantage of the new RHDV strains. A monitoring and release strategy, along with a decision framework to optimise the impacts from releasing candidate RHDV strains in the future is also being developed.

O34. Ponto-Caspian gobies in Switzerland – science meets management

Irene Kalchauer, Anouk N'Guyen, Philipp E. Hirsch, Patricia Burkhardt-Holm

University of Basel, Basel, Switzerland

Currently, Switzerland is experiencing an invasion of bighead goby *Ponticola kessleri* and round goby *Neogobius melanostomus*. These bottom-dwelling fish are native to the Caspian and Black Seas and have been extraordinarily successful at colonizing European and American freshwaters and coasts. Both species are naturally sessile and do not display migratory behaviour. The spread of round goby to the Great Lakes has been attributed to ballast water transport. In freshwater systems however, ballast water is hardly used. It is thus unclear whether, and if so, how the spread of either species within Europe depends on ship traffic. Regulations to minimize the transfer of species by freshwater ship traffic plainly do not exist, which can be attributed to this knowledge gap. To unravel the pathways of distribution, we investigate the genetic structure of harbour populations of bighead goby in Basel. We established microsatellite amplification protocols for bighead goby and found that two recently established and spatially close populations in two harbours in Basel are genetically distinct. We conclude that the two populations were introduced from separate sources. Interestingly, the two harbours are used by different ship types, cargo vessels and tank ships, respectively. Other approaches in the lab aim at procuring further management-relevant data. We are identifying the position of Ponto-Caspian gobies in the local food web to identify suitable predators. Also, we have developed spawning traps for egg removal, and propose a monitoring protocol for early detection of Ponto-Caspian gobies which allowed us to detect the invasion front of round goby in Switzerland.

O35. Applied research as a basis for sustainable management of non-native gobies

Patricia Burkhardt-Holm^{1, 2}

¹Program Man-Society-Environment, Dept. Environm Sci. University of Basel, Basel, Switzerland, ²Dept. of Biological Sciences, University of Alberta, Edmonton, Canada

After the advent of the non-native bighead goby *Ponticola kessleri* and round goby *Neogobius melanostomus* in Switzerland, fundamental questions about their biology and ecology have to be answered to lay a sound basis for sustainable management actions. This paper describes how we follow an interdisciplinary agenda to ensure successful management of invasive fish species. To document the pathways of the invasion, the genetic structure of both goby species and the role of recreational boats as vectors are investigated. To evaluate systematic egg removal as potential measure to reduce the propagule pressure, spawning traps are constructed. To develop measures to curtail the colonization of Swiss freshwater habitats, the inclusion of external experts is a prerequisite: governmental authorities are in charge of drafting and enforcing laws; fishermen are usually the first to observe non-native fish species, and boat owners may be affected by measures such as boat controlling and cleaning. A communication network was initiated, including stakeholder workshops, round tables, media coverage, information measures and political initiatives. As next steps, the development of educational tools in the frame of formation of fisher and ornamental fish traders is planned. Further, cost benefit analyses will serve to decide for most effective prevention and counter-measures.

O36. Estimating the risks related to non-native fish species – first application of FISK, the Freshwater Fish Invasiveness Screening Kit, in Southern Finland

Riikka Punttila¹, Lorenzo Vilizzi², Maiju Lehtiniemi³, Gordon Copp^{4, 5}

¹University of Helsinki, Helsinki, Finland, ²Murray-Darling Freshwater Research Centre, Wodonga Vic, Australia, ³Finnish Environment Institute (SYKE), Helsinki, Finland, ⁴Salmon & Freshwater Team, Cefas, Suffolk, UK, ⁵Trent University, Peterborough, Canada

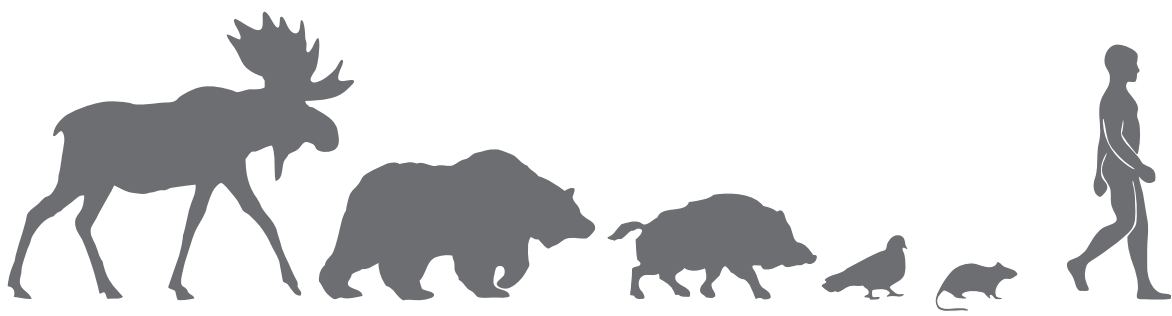
The climatic conditions of north temperate countries pose unique influences on the rates of invasion and the potential adverse impacts of non-native species, and methods are needed to evaluate these risks, beginning with the pre-screening of non-native species for potential invasives. Recent improvements to the Fish Invasiveness Scoring Kit (FISK) have provided a means (i.e. FISK v2) of identifying potentially invasive non-native freshwater fishes in virtually all climate zones. In the present study, FISK is applied for the first time in a north temperate country, i.e. Southern Finland and calibrated to determine the appropriate threshold score for fish species that are likely to pose a high risk of being invasive in this risk assessment area. The threshold between ‘medium’ and ‘high’ risk was determined to be 22.5, which is slightly higher than the original threshold for the UK (i.e. 19) and that determined for a FISK application in Japan (threshold = 19.8). This underlines the need to calibrate such decision-support tools for the different areas in which they are employed. The results show that management strategies should be revised in Finland regarding at least certain non-native fish species.

Silvicultural Pest Management

Oral presentations

Tuesday 24th September 2013, Pharma 2

- 09:30–09:50 **O37.** How does variation in moose population and forest resources explain moose damage in Finland? *Ari Nikula*
- 09:50–10:10 **O38.** Mitigation of damage caused by wild ungulates in lowland forest and farmland: an example from southern Poland, *Bogusław Bobek*
- 10:10–10:40 COFFEE
- 10:40–11:00 **O39.** Varying impacts of cervid, hare and vole browsing on growth and survival of boreal tree seedlings, *Mari Lyly*
- 11:00–11:20 **O40.** Increasing vole numbers cause more lethal damage to saplings in tree monocultures than in mixed stands, *Sonja Gilbert*
- 11:20–11:40 **O41.** Short and long term effects of vole damage to birch seedlings, *Heikki Henttonen*
- 11:40–12:00 **O42.** Effects of climate change on population dynamics of bank voles, *Jens Jacob*



O37. How does variation in moose population and forest resources explain moose damage in Finland?

Ari Nikula¹, Juho Matala², Jyrki Pusenius³

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The relationships between moose damage, population size and available resources are under conflicted discussion in Finland. There is substantial spatial and temporal variation in this phenomenon and obtaining data for studying relevant variables at an appropriate scale is problematic. As an attempt to do this we combined data that consists of: 1) moose damage locations in private forest plantations from year 2002 to 2008, 2) moose winter population size which is modelled based on hunters observations from 2001 to 2007, and 3) satellite image based multi-source National Forest Inventory data. From these data we calculated dependent variables in terms of the proportion of damaged area in relation to the area of different types of seedling stands. As independent variables we used the area of resources per moose in terms of land area, forestry land and different types of seedling stand measures. Both damage and independent variables were calculated at the level of Game Management Association, i.e. at the scale of 10²–10⁴ km² (n=278). We built several models between damage and resource per moose by using beta regression both at national level and at the Game Management District (n=14) level. At the national level, moose damage could be explained by several measures of resources but the performance of models were in general rather poor (pseudo-R² <0.1). At the Game management District level the performance of models was better (highest pseudo-R² >0.3) but there was a lot of variation among Districts.

O38. Mitigation of damage caused by wild ungulates in lowland forest and farmland: an example from southern Poland

Bogusław Bobek¹, Katarzyna Kopec², Dorota Merta¹, Tadeusz Mamok³, Marta Wojciuch-Ploskonka¹

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The Rudziniec Forest consists of several dozen forest complexes covering an area of 18,600 hectares, scattered among 37,300 hectares of farmlands. Data on protection of forest against deer damage were obtained from the Forest Service while data on damage by wild ungulates in farmlands were provided by hunters. The percentage of tree saplings damaged by deer was assessed on 21 m² plots. The population numbers of wild ungulates were determined from animals seen during collective hunts. The area of young forest plantation, principally consisting of pine (*Pinus silvestris*), larch (*Larix europea*), oak (*Quercus robur*), and beech (*Fagus silvatica*) saplings aged up to 10 years, is 1050.6 hectares, of which 643 hectares are protected by 418.6 km of fences. 243 hectares of plantations are protected chemically. The annual cost of protecting forest plantations against deer damage was 328,000 euros. The area of unfenced plantations where more than 50% saplings are damaged is 78.2 hectares. In 2012, the compensation paid by hunters to farmers reached 150,000 euros. The red deer population, estimated in March 2013, was 1833 individuals (98.5/1000 ha), while the respective numbers of roe deer and wild boars were estimated at 4988 (268.2/1000 hectares) and 863 (46.4/1000 hectares) animals. Because high costs of forest protection and protests by farmers it was decided that until the year 2017 the density of wild ungulates should be reduced by 30–70%. In the current hunting season (2013/2014) there is a plan to harvest 1033 red deer, 1163 roe deer, and 1129 wild boar.

O39. Varying impacts of cervid, hare and vole browsing on growth and survival of boreal tree seedlings

Mari Lyly¹, Tero Klemola¹, Elina Koivisto¹, Otso Huitu², Lauri Oksanen^{1,3}, Erkki Korpimäki¹

¹University of Turku, Turku, Finland, ²Finnish Forest Research Institute, Suonenjoki, Finland, ³Finnmark University College, Alta, Norway

Despite considerable observational data, there remains a debate about whether terrestrial trophic cascades are potent. Further, the impact of mammalian herbivores downwards on plants has been studied quite extensively, but typically with only a single herbivore species at a time. We conducted a novel comparison of the browsing effects of voles, hares and cervids upon the growth and survival of boreal tree seedlings. This was done by excluding varying assemblages of these key mammalian herbivores from silver birch, Scots pine and Norway spruce seedlings for three years. We hypothesised that the pooled impacts of the herbivores would be greater than that of any individual group, while cervids would be the group with the strongest impact. Growth of birch seedlings advanced when cervids were excluded whereas growth of seedlings accessible to cervids was hindered. Survival of all seedlings was lowest when they were accessible to voles and voles plus hares, whereas cervids seemed to not influence seedling survival. Our results show that the impact of herbivores upon woody plants can be potent in the boreal forests, but the mechanism and strength of this link depends on the tree and herbivore species in question. Risk of abated stand regeneration appears highest for the deciduous birch, though there is need for seedling protection also in coniferous stands. The clear cervid-mediated growth limitation of birch also indicates potential for a strong trophic cascade effect by mammalian top predators, currently returning to boreal ecosystems.

O40. Increasing vole numbers cause more lethal damage to saplings in tree monocultures than in mixed stands

Sonja Gilbert¹, Jocelyn Martel², Tero Klemola¹, Kai Norrdahl¹

¹Department of Biology, University of Turku, Turku, Finland, ²Department of Multidisciplinary Studies, Glendon College, York University, Toronto, Ontario, Canada

It has been proposed that there is a critical threshold density where herbivore pressure spreads from preferred plants to everything edible, leading to non-linear density effects on low-quality plants, such as tree saplings. We experimentally investigated whether survival of an unpalatable plant is similarly related to herbivore density in both monocultures and mixed stands. We established monocultures of unpalatable black alder (*Alnus glutinosa*) and mixed stands of black alder and five more palatable woody species in enclosures, where *Microtus* voles were introduced and their abundances monitored. Our results did not support the hypothesis of a critical threshold density in the food choice of voles. Signs of vole gnawing on the stem steadily increased in relation to vole abundance, and voles attacked saplings of all woody species studied already at low vole abundance (<50 voles per ha). However, the damage level varied according to the palatability of the woody species. The survival of black alder differed between monocultures and mixed stands; at higher vole abundances attacks had a stronger effect on sapling survival in the monocultures. In monocultures herbivores do not have alternatives and are therefore forced to become deadlier consumers. For relatively unpalatable saplings, mixed stands consisting of the commercial target species grown together with more palatable broadleaved species may be viewed as an insurance against occasional peaks in herbivore density. Herbivores are likely to taste the saplings in mixed stands, but the consequences of herbivore activity should be less destructive in the presence of more palatable species.

O41. Short and long term effects of vole damage to birch seedlings

Heikki Henttonen¹, Jukka Niemimaa², Matti Rousi³, Otso Huitu⁴, Paavo Rahkila⁵, Pyy-Matti Rahkila⁵, Panu Rahkila⁵
¹Finnish Forest Research Institute, Vantaa, Finland, ²Finnish Forest Research Institute, Vantaa, Finland, ³Finnish Forest Research Institute, Vantaa, Finland, ⁴Finnish Forest Research Institute, Suonenjoki, Finland, ⁵Univ. Jyväskylä, Jyväskylä, Finland

In Finland, damage by voles is a great problem in forest regeneration and afforestation of former farmland. Silver birch (*Betula pendula*) is susceptible to damage by *Microtus* voles up to 5 years after planting. Damage by voles and moose has reduced the planting of birch on productive soils and instead Norway spruce (*Picea abies*) has to be used. There is a lot of information on the short-term impacts of vole damage on birch seedlings, i.e. severe damage killing seedlings immediately, and increasing mortality within 1–3 years. However, there is also plenty of minor damage to birch seedlings, but their long-term impacts, e.g. fungal and bacterial infections colonising through small wounds, have not been studied. We planted an experimental area on former farmland in 1988, and monitored vole damage in individual seedlings during vole population peaks in 1988 and 1991. Half of the seedlings died during the vole peaks or soon after, and a high proportion of surviving ones had minor damage. The birches were cut in 2011, and with prior knowledge on the individual history of each birch, we studied possible fungal infections and their spread from minor woundings 23–20 years earlier. Excluding some severe rotting cases, most of the trees had managed to control the infection, leaving only a small diameter section of dark wood in the core of the basal trunk. This does not prevent the use of timber for plywood production.

O42. Effects of climate change on population dynamics of bank voles

Jens Jacob¹, Daniela Reil^{1,2}, Christian Imholt¹
¹Julius Kühn-Institut, Federal Research Centre for Cultivated Plants, Vertebrate Research, Münster, Germany, ²University of Potsdam, Institute of Biochemistry and Biology, Animal Ecology, Potsdam, Germany

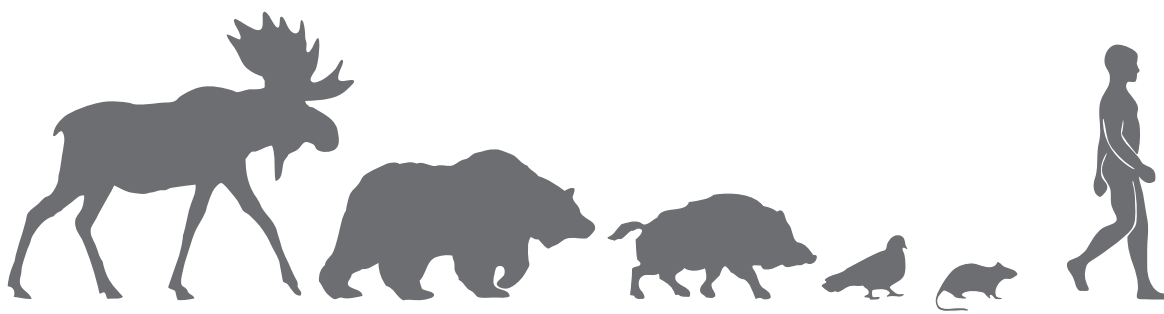
Bank voles (*Myodes glareolus*) are common inhabitants of forest habitats in most of Europe. They are the host of Puumala hantavirus (PUUV) that causes nephropathia epidemica in humans. The number of human infections depends on the population size of (infected) bank voles, which fluctuates multi-annually. During outbreaks bank voles can also cause significant damage to forest trees. We tested whether fluctuations in bank vole population size are related to weather constellations and how future climate change may affect outbreak dynamics, as considerably increased bank vole abundance may impact public health and crop protection. Effects of weather parameters on population abundance of bank voles were assessed by correlating time series of bank vole abundance from two German regions with weather parameters using classification and regression tree analyses. Forecasts for the A1B-scenario for 2031–2060 were considered to compare recent values (1969–2000) of relevant weather parameters to possible future changes in these weather parameters to roughly estimate potential future changes in bank vole dynamics. Certain weather parameters of the previous year and the year before correlated well with low bank vole abundance and other weather constellations correlated well with high bank vole abundance. When comparing weather-related recent bank vole abundance categories to the projection period no clear trend towards an increase or decrease in bank vole abundance was found. This indicates that dramatic future changes in bank vole abundance based on weather are unlikely.

Urban Pest Management

Oral presentations

Tuesday 24th September 2013, Pharma 2

- 14:00–14:20 **O43.** Rat management: improvements in the city of Zurich, Switzerland, *Marcus Schmidt*
- 14:20–14:40 **O44.** Population management of overpopulated rock hyraxes (*Procavia capensis*) in residential areas, *Roelof Wiid*
- 14:40–15:00 **O45.** Anticoagulant resistance in Norway rats in an urban park in Paris: influence of anticoagulant exposure, *Philippe Berny*
- 15:00–15:30 COFFEE
- 15:30–15:50 **O46.** The impact of bait boxes on house mouse (*Mus domesticus*) bait uptake in UK domestic dwellings, *Gai Murphy*
- 15:50–16:10 **O47.** Laboratory test for efficacy of six rodenticides against bank voles (*Myodes glareolus*), *Erik Schmolz*
- 16:10–16:30 **O48.** Can second-generation anticoagulant rodenticides increase the frequency of resistant animals in natural populations of Norway rats? *Philippe Berny*



O43. Rat management: improvements in the city of Zurich, Switzerland

Marcus Schmidt², Isabelle Landau Lüscher³, Gabi Müller¹

¹AWEL Amt für Abfall, Wasser, Energie und Luft, Zürich, Switzerland, ²Département Biomedizin, Anatomisches Institut der Universität Basel, Basel, Switzerland, ³Institute of Parasitology, Zürich, Switzerland

We outline the situation of practical control of Norway rats (*Rattus norvegicus*) in Zurich from 1997 to 2012 and describe all efforts to increase the efficiency of rat control in the city. After a reorganisation in 2003 the UPAS gave up practical insect control and delegated it to private companies. This left more time to improve rat control and other health projects. In 2004 and 2005 stationary bait boxes were placed in public “rat areas”. New baits were checked for their attractiveness and efficient use. Our baits used in public areas all have low toxicity for non-target animals. No problems have emerged concerning resistance and all baits have worked successfully in controlling rats up to date. We present data concerning the rat situation of the last 15 years, the reduced use of rat bait and the improved work efficacy. In 2009 we implemented a web based Arc-GIS programme to visualize all registered rat cases on the city map. We inspect private houses or properties when rat problems appear. Often the causes are inappropriate waste disposal and broken sewer drains. Based on the cantonal law we can enforce the repair of damaged sewers. Often we solve the problems together with the Waste Disposal & Recycling Department. Since 2007 the latter has successively equipped parts of the city with closed underground waste containers which are rat-safe. This and other measures strongly improved the hygiene of the city.

O44. Population management of overpopulated rock hyraxes (*Procavia capensis*) in residential areas

Roelof Wiid, Hennie Butler

University of the Free State, Bloemfontein, Free State, South Africa

Frequent reports of hyrax invasions in suburban residential areas within the Free State Province of South Africa have led to the investigation of the magnitude of the problem as well as identification of possible solutions. Areas with the highest number of reports were identified and population densities determined using the Lincoln Index and the Robson-Whitlock Technique. Populations within residential wildlife estates were also determined and compared to populations in the wild. Results show that, due to the lack of natural predators as well as other anthropogenic factors, hyrax populations within suburban residential areas and residential wildlife estates demonstrate an annual exponential increase. Some populations exceeded the natural limits of 30 to 40 individuals by 520%. This increase led to a food and habitat shortage which forced hyraxes into residential areas in search of additional refuges and food sources. This influx contributes to damages to gardens and buildings. In order to manage hyrax populations, several preventative as well as control methods were assessed. Relocation was identified as the preferred method to control hyrax populations in residential areas. Thirty-five individuals of different gender and ages were captured from overpopulated residential areas and relocated as family units to suitable uninhabited areas. Population composition ratios as regards to males, females, adults, sub-adults as well as juveniles were considered before relocating groups. In order to determine the success of relocation, all individuals were freeze-branded with liquid nitrogen and kept in captivity for one week prior to release. After release hyraxes were monitored monthly.

O45. Anticoagulant resistance in Norway rats in an urban park in Paris: influence of anticoagulant exposure

Philippe Berny¹, Isabelle Fourel¹, Virginie Lattard¹, Gwenaél Yourc'h³, Jean-François Cosson²

¹Vetagro Sup, Marcy l'étoile, France, ²CBGP-INRA, Montpellier, France, ³INRA, Clermont-Theix, France

The objective of this work was to sample rats (*Rattus norvegicus*) in a urban park near Paris, in order to identify resistance to anticoagulants. The park was initially selected as a negative control for resistance because it is entirely closed and no anticoagulant is being used. Rats were sampled in January 2012. A total of 86 individuals (37M, 49 F) were captured in 5 different areas of the park (B, C, D, E and F). Genetic studies were conducted on 13 loci of microsatellites of rats, to identify the genetic diversity of the various individuals. Identification of resistance was done on the Y139F mutation by qPCR. Anticoagulant residues were monitored by LC-MS-MS on liver samples. The results showed that the rat populations were genetically related and spatially structured with very few migrants (4 males) and limited genetic diversity. Anticoagulant resistance was very frequent (62.5%), with 42% homozygote resistant. The distribution of R or S allele was site-related. Anticoagulant residues were detected in 62% of the rats trapped (brodifacoum, bromadiolone, chlorophacinone, difenacoum, difethialone) at concentrations ranging from 1 to 1508 µg/kg-1. Interestingly, AVKs were also site-specific. Bromadiolone only was identified in site F. Brodifacoum, difenacoum and chlorophacinone were detected at higher concentrations in the liver of rats trapped in sites B, C, D, where the frequency of the R allele was higher. These results suggest that rats are still exposed to anticoagulants and that the small amounts detected may facilitate resistance selection in this park.

O46. The impact of bait boxes on house mouse (*Mus domesticus*) bait uptake in UK domestic dwellings

Gai Murphy

University of Salford, SALFORD, UK

The ability to control infestations in urban dwellings is an important aspect of public and environmental health. A number of authors have considered the impact of house mouse (*Mus domesticus*) infestations on the health of those living in infested properties. The challenge is of course to find an appropriate method to maximise bait take, so that control strategies are effective and efficient thus reducing exposure to infestations. Using the Latin Square technique, whole wheat was placed in domestic properties, bait take was weighed daily and bait was presented in one of four ways, in an open tray, in a cardboard box, in a tamperproof bait box and a wax bait in a cardboard box. The trials took place over 5 consecutive days. The results confirmed that to maximise bait take, pest technicians should place bait in cardboard boxes. Three quarters of the bait consumed by mice was taken from cardboard boxes. However, risk assessments often militate against the use of cardboard boxes in favour of tamperproof bait boxes and there is a clear need to find an acceptable balance between safety and efficacy. This requires a sensible debate with regulators, so that a range of rodenticides are available and that safe ways of presenting bait in urban settings are agreed.

O47. Laboratory test for efficacy of six rodenticides against bank voles (*Myodes glareolus*)

Erik Schmolz, Agnes Kalle
Federal Environment Agency, Berlin, Germany

Bank voles (*Myodes glareolus*) do not only damage forest trees but are reservoir hosts for the PUUV hanta-virus, the predominant disease transmitted by rodents in Germany. Bank voles may enter homes, shelters, animal stables and visit public picnic places, where they leave infectious excretions. To assess the efficacy of rodenticides to control bank voles for public health protection, we developed a test system to quantify the efficacy of anticoagulant rodenticides (warfarin 0.079%, chlorophacinone 0.075%, coumatetralyl 0.0375% and brodifacoum 0.005%) as well as zinc phosphide (0.8%) and corn cob (95%). The test arena was a macrolone type IV cage with a modified lid. The test duration was 14 d for no-choice and 21–28 d for choice tests. The voles were single-caged. Cages contained a plastic shelter, a sheet of cellulose as nest material, a dish with laboratory bedding in order to prevent voles from urinating on the bait product and one or two small feeding dishes with bait product or challenge diet (in choice tests). All products with anticoagulants produced 100% mortality in no-choice and choice tests. Time until death was between 6 and 8 days in average. Zinc phosphide caused 100% mortality in a no-choice test and killed the voles shortly after ingestion, but was not taken up under choice conditions. Application of Corn Cob resulted in 70% mortality in a no-choice test, but death was not correlated with bait uptake. The main effect of Corn Cob may be starvation rather than a physiological effect of the active ingredient.

O48. Can second-generation anticoagulant rodenticides increase the frequency of resistant animals in natural populations of Norway rats ?

Philippe Berny, Isabelle Fourel, H       Defrance, Virginie Lattard
Vetagro Sup, Marcy l'      , France

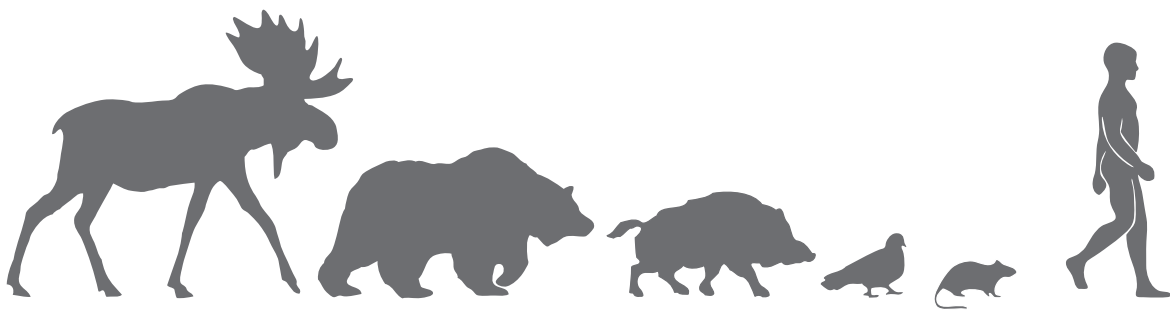
Anticoagulant (AVK) exposure may result in the selection of resistant rodents. This has been established for first generation compounds. It is generally considered that more recent second generation AVKs should not result in resistant rodent selection because of their high efficacy on all known resistant strains. The purpose of this study was to evaluate the AVK-resistance status and evolution over time in two rodent populations before and after AVK application. Two farms were selected. Brodifacoum or difethialone were used. Bait consumption was monitored. Rodents were captured either alive (traps) or when found dead after AVK exposure. AVK resistance status was determined (Vkorc1 genotyping) and AVK exposure assayed (liver residue). The genetic background of both populations was determined. The trial was continued for 8–9 months post AVK application. In both sites, the prevalence of resistant alleles was high (80%) at the beginning of the trial. Rat populations were considerable in size (>100 individuals) and very similar. Brodifacoum and difethialone were detected after application and afterwards. Although rat populations 8 months after application were not genetically related to the first ones, they had a higher prevalence of mutation (100%R), a high frequency of detection of liver residues of brodifacoum or difethialone and concentrations ranging from 10 to 750 µg/kg, lower than after AVK application. These results suggest that baits remain available, resulting in exposure of new populations to AVKs, which can in turn exert a selection pressure on them, leading to increased prevalence of resistance.

Zoonoses and Parasites

Oral presentations

Wednesday 25th September 2013, Pharma 1

- 09:30–09:50 **O49.** Negative relationship between abundances of two ticks: biotic interaction or niche segregation? *Emil Tkadlec*
- 09:50–10:10 **O50.** Identifying the hazards correlated with rodent and tick-borne diseases in Europe, *Annapaola Rizzoli*
- 10:10–10:40 COFFEE
- 10:40–11:00 **O51.** Insectivore-borne hantaviruses in Finland, *Tarja Sironen*
- 11:00–11:20 **O52.** Life-long shedding of Puumala hantavirus in wild bank voles (*Myodes glareolus*), *Liina Voutilainen*
- 11:20–11:40 **O53.** Factors influencing human Puumala virus infections in Germany, *Daniela Reil*
- 11:40–12:00 **O54.** Biome specific epidemiologies of Puumala hantavirus in Europe, *Heikki Henttonen*



O49. Negative relationship between abundances of two ticks: biotic interaction or niche segregation?

Emil Tkadlec^{1,2}, Pavel Šíroký³, Tomáš Václavík^{1,4}

¹Palacky University Olomouc, Department of Ecology and Environmental Sciences, Olomouc, Czech Republic, ²Institute of Vertebrate Biology Academy of Sciences of the Czech Republic, Studenec, Czech Republic, ³University of Veterinary and Pharmaceutical Sciences, Faculty of Veterinary Hygiene and Ecology, Department of Biology and Wildlife Diseases, Brno, Czech Republic, ⁴Helmholtz Centre for Environmental Research—UFZ, Leipzig, Germany

Understanding species distributions is central to predicting the risk of tick-borne disease occurrence. Despite considerable advance over the last two decades, accounting for biotic interactions in geographic models still remains among the main challenges. Here we examined whether the negative relationship between abundances of two sympatric European ticks, *Dermacentor reticulatus* and *Ixodes ricinus*, can be explained by competitive interaction or ecological niche segregation. After accounting for possible sample bias, we applied the static regression model based on a modified Lotka-Volterra model for interspecific competition. The negative relationship between log-abundances of the tick species was not removed by 7 principal components derived from 25 spatial variables on temperature, precipitation, topography and soil moisture, leading to nonzero estimates of competition coefficients α_{12} and α_{21} . However, the analysis of abundance responses to habitat variables showed that *Dermacentor* preferred warmer and wetter sites with greater diurnal and seasonal variation in temperature but with less seasonality in precipitation than *Ixodes*. These findings confirmed that habitat characteristics contribute significantly to the inverse relationship between the tick abundances, while still leaving some room for the effects of biotic interaction.

O50. Identifying the hazards correlated with rodent and tick-borne diseases in Europe

Annapaola Rizzoli¹, Daniele Arnoldi¹, Heidi Hauffe¹, Maria Kazimirova², Markus Neteler¹, Roberto Rosà¹, Rosso Fausta¹, Michail Stanko³, Valentina Tagliapietra¹, Voutilainen Liina⁴, Heikki Henttonen⁴

¹Edmund Mach Foundation, San Michele all'Adige, Italy, ²Institute of Zoology, Slovak Academy of Sciences, Bratislava, Slovakia, ³Parasitological Institute, Slovak Academy of Sciences, Košice, Slovakia, ⁴The Finnish Forest Research Institute, Vantaa, Finland

Wildlife zoonoses transmitted by rodents and ticks cannot be easily controlled with the use of chemical pesticides or large-scale culling, for ethical, economic, health and logistical reasons. Instead, reducing the exposure of humans and domestic animals to pathogens and their vectors in focal areas, during periods of the year when these hazards are present, is a much more realistic option. However, these recommendations are only possible if such hazards are predictable. Within the framework of the European project EDENext (www.edenext.eu) we established a multiannual monitoring survey in three European countries (Italy, Slovakia and Finland). Within our study sites, standardised collections of questing ticks and rodents were carried out for three years. Serological and molecular investigations were carried out on rodents and questing ticks to identify their infectious status and prevalence of several pathogens of interest for public health in Europe (Hantavirus, TBEV, Lyme spirochaetes). In this presentation, a summary of the preliminary findings and criteria for selection of early warning predictors will be presented and discussed.

O51. Insectivore-borne hantaviruses in Finland

Jiaxin Ling¹, Liina Voutilainen^{1,2}, Jukka Niemimaa², Antti Vaheri¹, Olli Vapalahti¹, Heikki Henttonen², Tarja Sironen¹

¹University of Helsinki, Haartman institute, Helsinki, Finland, ²Finnish Forest Research Institute, Vantaa, Finland

Hantaviruses (family *Bunyaviridae*) are important human pathogens that cause hemorrhagic fever with renal syndrome and hantavirus cardiopulmonary syndrome. Rodents have been regarded as principal reservoir hosts of hantaviruses, however, hantaviruses have been recovered also from insectivores (order Soricomorpha). For many of these newcomers, only sequence data are so far available, and attempts to isolate these viruses have earlier often failed. This has hampered the analysis of the infectivity and pathogenicity of these viruses to humans and other vertebrates. In this study, we have searched for novel insectivore-borne hantaviruses in Finland. We screened tissue samples of 6 different insectivore species by nested-RT-PCR that was targeted to the highly conserved domain of the RNA-dependent RNA-polymerase. Positive tissue samples were chosen for virus isolation in Vero E6 cells. Furthermore, we produced antibodies against Seewis hantavirus, and used the antibodies to set up an antigen screening test. On average, 30% of the shrews were determined hantavirus-positive, with hantavirus sequences being recovered from the common shrew (*Sorex araneus*), the pygmy shrew (*Sorex minutus*) and water shrew (*Neomys fodiens*). These three hantaviruses that circulate in Finland are geographically widespread and they show great sequence variation. The cell culture isolates will allow for serological screening of human samples, enabling us to determine whether these viruses are pathogenic for humans.

O52. Life-long shedding of Puumala hantavirus in wild bank voles (*Myodes glareolus*)

Liina Voutilainen^{1,2}, Tarja Sironen^{1,2}, Elina Tonteri^{2,3}, Anne Tuiskunen³, Maria Razzauti^{1,2}, Malin Karlsson^{3,4}, Maria Wahlström³, Jukka Niemimaa¹, Heikki Henttonen¹, Åke Lundkvist^{3,4}

¹Finnish Forest Research Institute, Vantaa, Finland, ²Department of Virology, Haartman Institute, University of Helsinki, Helsinki, Finland, ³Department of Microbiology, Tumor and Cell Biology, Karolinska Institutet, Stockholm, Sweden, ⁴Swedish Institute for Communicable Disease Control, Solna, Sweden

Hantaviruses are rodent-borne zoonotic pathogens. They are transmitted via aerosolized excreta of rodent hosts. Based on laboratory experiments, rodent hosts are believed to shed the virus intensively only for some weeks, after which virus is shed sporadically in low quantities. Studies on hantavirus shedding by wild rodents are scarce. We analysed the presence and relative quantity of Puumala hantavirus (PUUV) RNA in saliva, faeces and urine of wild bank voles. We found only a slight decline in the likelihood of shedding PUUV within 8 months from infection, and no change in the shed quantity. Our results contradict the current view of two-phased hantavirus shedding pattern that is commonly assumed in hantavirus transmission models. We believe the long shedding in nature is due to trade-offs between reproductive effort, longevity and immune response. Prolonged shedding may be necessary for hantaviruses to survive over host population bottlenecks, especially in fragmented landscapes.

O53. Factors influencing human Puumala virus infections in Germany

Daniela Reil^{1,3}, Christian Imholt^{1,2}, Sabrina Schmidt², Ulrike Rosenfeld², Nastasja Kratzmann², Rainer Ulrich², Jana Eccard³, Jens Jacob¹

¹Julius Kühn-Institute, Federal Research Centre for Cultivated Plants, Institute for Plant Protection in Horticulture and Forests, Vertebrate Research, Münster, North Rhine-Westphalia, Germany, ²Friedrich-Loeffler-Institut, Federal Research Institute for Animal Health, Institute for Novel and Emerging Infectious Diseases, Greifswald - Insel Riems, Mecklenburg-Vorpommern, Germany, ³University of Potsdam, Institute of Biochemistry and Biology, Animal Ecology, Potsdam, Brandenburg, Germany

Puumala virus (PUUV), a hantavirus species widely spread in Europe, can cause nephropathia epidemica in humans. It is associated to forest living bank voles (*Myodes glareolus*), which show seasonal variations and multiannual fluctuations in population size partially related to food availability. Our aim was to investigate if the number of human PUUV infections, bank vole population dynamics, and masting events of beech (*Fagus sylvatica*) potentially correlate. We monitored seasonal changes in bank vole population dynamics (three times a year from 2010–2013 in several regions of Germany using Ugglan live traps), and analysed blood samples of each trapped bank vole for PUUV-specific antibodies. Vole population densities were positively correlated with PUUV seroprevalence, and abundance of seropositive bank voles was positively related to the number of notified human PUUV infections. Analyses of time series (2000–2012) of bank vole abundance, beech fructification and human PUUV infection showed that bank vole population outbreaks and increased human PUUV infection rate are preceded by beech mast. Since spring 2013, we additionally applied a PUUV rapid field test for rodents, which was calibrated to PUUV serology. A reliable rapid test could help health authorities in the future to quickly assess the current risk of human PUUV infection. The studies are commissioned and funded by the Federal Environment Agency (UBA) within the Environment Research Plan of the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) (grant number 3709 41 401 and 3713 48 401) and by the European Commission (EDENext).

O54. Biome specific epidemiologies of Puumala hantavirus in Europe

Heikki Henttonen

Finnish Forest Research Institute, Vantaa, Finland

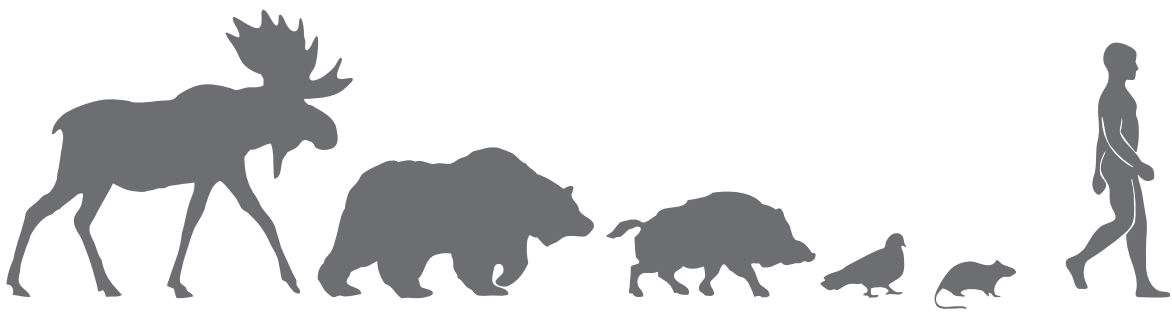
Hantaviral epidemiological patterns are related to the dynamics of reservoir rodent species. In temperate Europe masting is the important driver of hantaviral epidemics (mostly due to Puumala virus, PUUV) and it has been suggested that warm summers induce masting. In contrast, in boreal northern Europe, specialist predation is thought to be the main driver of vole fluctuations. Consequently, the underlying top-down or bottom-up causes of rodent fluctuations are different. In temperate Europe, masting frequency may have increased due to the warming of summers, resulting in increased frequency of outbreaks of forest rodents and hantaviral HFRS. In addition to short-term fluctuations or outbreaks in rodent dynamics, there are long-term trends, superimposed on the shorter “cycles”, possibly due to the climatic changes, as exemplified e.g. by the national long-term monitoring of vole fluctuations in Finland. We documented clear seasonal differences in the transmission dynamics of PUUV between these two biomes, affecting also seasonality of human epidemics. We have further documented the role of landscape patterns (homogenous taiga vs. fragmented temperate forests) in rodent/virus dispersal, and differences in the presence or absence of host threshold densities for the PUUV occurrence. In addition, temperature and moisture affect virus survival outside the host, affecting indirect transmission geographically. Also, geographic differences in the immunogenetics of reservoir rodents can affect their susceptibility. In conclusion, it is important to realize that within the same host/virus system, biome specific hanta epidemiologies occur, which highlights the importance of geographically comparative studies in Europe, or in any host/pathogen system.

Human – Animal Social Conflicts

Oral presentations

Thursday 26th September 2013, Pharma 1

- 09:30–09:50 **O55.** Management of cormorant populations: A tool to handle cormorant-fisheries conflicts? *Alexandra Hyldgaard*
- 09:50–10:10 **O56.** Beaver dispersal in man-made watercourses in Karelia and its consequences, *Fyodor Fyodorov*
- 10:10–10:40 COFFEE
- 10:40–11:00 **O57.** Fallow deer of Lemnos Island: current situation and alternatives for sustainable management, *Mariama Mattila*
- 11:00–11:20 **O58.** Baltic seals – balancing between sustainable ecosystem management and fisheries (ECOSEAL), *Raisa Tiilikainen*
- 11:20–11:40 **O59.** Analysing Baltic grey seal (*Halichoerus grypus*) population management options, *Lauri Ronkainen*
- 11:40–12:00 **O60.** Demographic structure and body condition of Baltic grey seals: are the problem seals a random sample of the population? *Kaarina Kauhala*
- 12:00–13:00 LUNCH
- 14:00–14:20 **O61.** Assessment of the illegal use of poisoned baits for pest control and their impact on wildlife on the island of Crete (Greece), *Stavros Xirouchakis*
- 14:20–14:40 **O62.** Large predators – distribution, number, management and relationships with humans in the Russian North-West, *Pjotr Danilov*



O55. Management of cormorant populations: a tool to handle cormorant-fisheries conflicts?

Thomas Bregnballe¹, Dave Carss², Alexandra Hyldgaard¹

¹Aarhus University - Department of Bioscience, Rønde, Denmark, ²Centre for Ecology and Hydrology, Edinburgh, UK

The cormorant is a large waterbird that consumes approx. 500g of fish per day. It forages in all types of shallow waterbodies. The cormorant is migratory and occurs throughout Europe outside the breeding season. It is efficient in locating profitable feeding areas, and it can occur in large numbers when and where fish temporarily become easily available. As a consequence of its prey choice, its efficient foraging behaviour and capacity to mount a numerical response, it has been in conflict with fisheries for at least two centuries. Human harassment kept numbers down for decades, and the core breeding areas in Europe held a population of just 4000 breeding pairs in the early 1960s. The species was then placed under protection and the population expanded, in particular during the 1980s and 1990s, exceeding 230,000 pairs by 2006. Due to increasing conflicts with fisheries, aquaculture, angling and fish conservation, demands for population control have intensified locally, nationally and at the Pan-European scale. We provide examples of the different attitudes and population control measures to reduce conflicts with cormorants in Europe. We also describe results and discuss pros and cons of using population management as a tool to handle the variety of conflicts.

O56. Beaver dispersal in man-made watercourses in Karelia and its consequences

Fyodor Fyodorov

Institute of Biology Karelian Research Centre of RAS, Petrozavodsk, Russia

Canadian and European beavers have become an essential component of waterside coenoses in Karelia and their intensive engineering activities often result in conflict with the interests of people. In the north of Karelia up to 55 % (n=43) of beaver colonies are in the vicinity of highways, railway, or power lines, i.e. areas where the capacity of beaver habitats has been enhanced by the post-logging change in woody vegetation. The average beaver population density is 3–5 colonies per 10 km of the communication facilities (whereas the density in 10 km of natural shoreline is 1–2 colonies). In 60 % (n=22) of roadside colonies beavers blocked drainage pipes, generating a risk of highway flooding or even erosion of the railway embankment. In the south of Karelia, where the conditions are more favourable for beavers, their population density is higher – 4–8 colonies per 10 km of shoreline. The specific conditions and heavy nuisance along roads however result in a considerably lower beaver population density than in the north – 0.8–1 colonies per 10 km of roadside watercourses. As they dispersed, beavers started settling in another type of man-made watercourses – forest and farmland drainage ditches. In the southernmost (Olonetsky) district of Karelia up to 37 % (n=83) of all beaver colonies concentrate around drainage ditches. The population density in forest drainage ditches ranges from 2 to 4 colonies per 10 km. In many colonies beavers build dams (96.6%, n=39), which cause flooding of the territory, deterioration of the drainage system condition and die-back of forest plantations.

O57. Fallow deer of Lemnos Island: current situation and alternatives for sustainable management

Mariama Mattila¹, Ioannis Hadjigeorgiou²

¹University of Turku, Turku, Finland, ²Agricultural University of Athens, Athens, Greece

In the 1970s a few European fallow deer (*Dama dama dama*) were introduced to a fortress peninsula at Myrina town of the island of Lemnos (NE Aegean sea), where they established a small population. The aim of this study is to estimate current ungulate population in the introductory area, to estimate biological carrying capacity, and to evaluate the social carrying capacity of this species, providing alternatives for sustainable management. A visual inspection method (first-site data) was used to estimate population size of all grazing animals in the fortress peninsula area. The total number of ungulates observed was 39, including 32 fallow deer and 7 feral goats (*Capra capra*). For total ground cover inventory we used a sub-plot sampling method. In most areas trees were either browsed or frayed, vegetation cover was insufficient and dry mass amount was not enough to support the whole ungulate population. However, lack of nutritious matter supply is covered by additional food and water supply provided by Myrina Municipality and Volunteers. Data for the social carrying capacity evaluation was collected during personal interviews with Myrina town major stakeholder representatives. They had a general positive attitude towards keeping deer in the fortress area as tourist attraction and as admiration for the whole island. In case of escape from the fortress area deer cause social impacts. In general, deer population management initiatives focus on suitable deer habitat improvement and additional planting of more nutritious local vegetation species. There is a need for year-around vegetation monitoring, and a predictive fallow deer management plan.

O58. Baltic seals – balancing between sustainable ecosystem management and fisheries (ECOSEAL)

Raisa Tiilikainen¹, Kaarina Kauhala², Annika Herrero¹, Jarno Vanhatalo³, Inari Helle³, Lauri Ronkainen³, Reijo Käkälä³, Teija Aho⁴, Karl Lundström⁴, Markus Vetemaa⁵

¹Finnish Game and Fisheries Research Institute, Helsinki, Finland, ²Finnish Game and Fisheries Research Institute, Turku, Finland, ³University of Helsinki, Helsinki, Finland, ⁴Swedish University of Agricultural Sciences, Öregrund & Lysekil, Sweden,

⁵University of Tartu, Estonian Marine Institute, Tartu, Estonia

The population size of Baltic seals has recently increased. Along with the growing seal populations, seal-induced damages to fisheries, i.e. both fish catch loss and damage to gear, have increased, resulting in a conflict between seals and coastal fisheries. Additionally, seals are suspected to have a crucial impact on the populations of economically important fish species. To decrease seal damage, additional seal hunting licenses have been granted. On the other hand, unknown numbers of seals die annually as by-catch of fisheries. Hence, the management of the Baltic seal populations is nowadays largely balancing between the attainment of a favourable conservation status and acceptable level of losses to the coastal fishery. In the international ECOSEAL project we study and analyse the spatial and temporal variability in the diet of grey seals (*Halichoerus grypus*) based on samples from hunted and by-caught seals in the Central Baltic area using several methods (analyses of digestive tract hard part and DNA remains, muscle and liver stable isotopes and blubber fatty acids). The aim of the project is to produce a bioenergetic model of the ecological role of grey seals in the Baltic sea, and to gather information on the demographic structure of hunted and by-caught seals, which will be used further in a mathematical risk analysis model on the management decisions concerning Baltic seal populations, and to develop solutions and tools to diminish the conflict between seals and fisheries.

O59. Analysing Baltic grey seal (*Halichoerus grypus*) population management options

Lauri Ronkainen¹, Kaarina Kauhala², Olle Karlsson³, Markus Ahola², Jarno Vanhatalo⁰

¹University of Helsinki, Helsinki, Finland, ²Finnish Game and Fisheries Research Institute, Turku, Finland, ³Museum of Natural History, Stockholm, Sweden

A biologically consistent population dynamics model is constructed to estimate temporal changes in the seal population and to predict the development of the population under alternative management options. A Bayesian approach is used to estimate the uncertain life variables as well as natural and by-catch mortality. The prior information concerning the model and its parameters are gathered from literature. Data consist of population surveys and hunting and by-catch statistics. Management options are constructed based on interviews of hunting, fishery, seal research and conservation experts.

O60. Demographic structure and body condition of Baltic grey seals: are the problem seals a random sample of the population?

Raisa Tiilikainen¹, Kaarina Kauhala², Annika Herrero¹

¹Finnish Game and Fisheries Research Institute, Helsinki, Finland, ²Finnish Game and Fisheries Research Institute, Turku, Finland, ³Finnish Game and Fisheries Research Institute, Helsinki, Finland

For management purposes it is essential to know whether the seals that cause problems to coastal fisheries are a random sample of the population or not. In the ECOSEAL project we collected samples of Baltic grey seals (*Halichoerus grypus*) from hunters and fishermen to be able to compare the demographic structure and body condition (sternum blubber thickness) of the ‘problem seals’ and seals shot during normal hunting from the outer archipelago. The aim was to find out the regional and temporal differences between the by-caught seals and those shot near the coastal fishing gear (mainly traps) and the seals hunted from the outer archipelago. In Finland, most seals shot near fishing gear (n = 24) or by-caught in fishing gear (n = 22) were adult males killed in autumn. Also some pups of both sexes and sub-adult males were by-caught. Few females (mainly pups) were shot near fishing gear. Most seals killed during normal hunting (n = 45) were shot in spring from ice and almost half of them were pups, males more than females. About 20% of hunted seals were adult females. Most by-caught seals in Estonia (n = 35) were pups. In Finland, the problem seals were leaner than hunted seals in spring but no difference in body condition between the groups was found in autumn. This information may be used in the management of seals populations and aiming the harvest towards the problem causing part of the seal population.

O61. Assessment of the illegal use of poisoned baits for pest control and their impact on wildlife on the island of Crete (Greece)

Stavros Xirouchakis, Giorgos Andreou, Costas Grivas, Michalis Probonas, Kaliopi Baxevasi, Maria Sakellari
Natural History Museum of Crete, University of Crete, P.O. Box 2208, Heraklion, Crete, Greece

In this study we present data collected during the years 2000–2012 on the island of Crete (Greece) on the illegal use of poison substances against pests. Our aim has been the assessment of their impact on avian populations and the production of management tools for mitigation purposes. Overall we collected 476 avian carcasses as well as sick or injured birds belonging to 18 species of which the griffon vulture (*Gyps fulvus*), the bearded vulture (*Gypaetus barbatus*), the golden eagle (*Aquila chrysaetos*), the common buzzard (*Buteo buteo*), the kestrel (*Falco tinnunculus*), the peregrine falcon (*Falco peregrine*), Eleonora's falcon (*Falco eleonora*), the barn owl (*Tyto alba*) and the raven (*Corvus corax*) were found to be poisoned. Griffons, buzzards and barn owls accounted for 48%, 35% and 6% of the poisoning cases respectively. Agrochemicals such as methomyl, fenthion, carbofuran, paraquat and parathion and various anticoagulant rodenticides have been mostly used by farmers, stock-breeders and hunters against wasps, corvids, mustelids, stray dogs, and feral cats. Most of the poisoning incidences took place in late summer-early autumn (72.2%), coinciding with the pre-shooting season when farmers tried to discourage hunting activity in the rangelands. Public awareness, land use regulations, capture and translocation of problematic animals, taste deterrents and bird scarers are the proposed mitigation techniques though they have yet to be applied and properly evaluated. Direct persecution should be individual-specific and the ultimate alternative for the control of certain stray dog species.

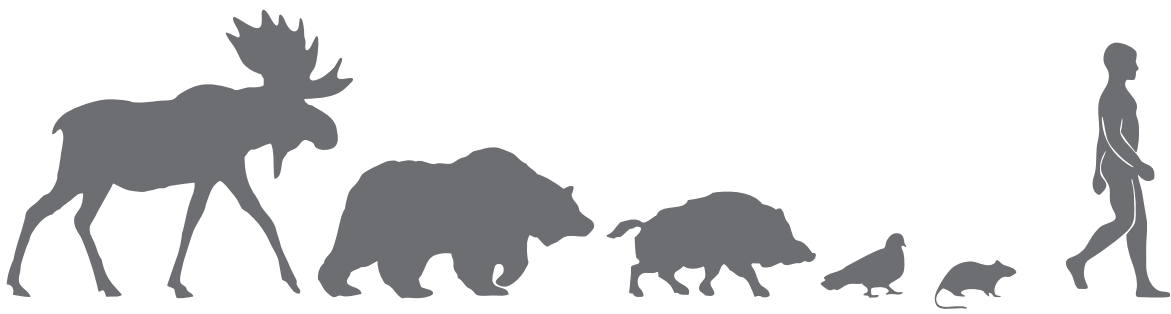
O62. Large predators – distribution, number, management and relationships with humans in the Russian North-West

Piotr Danilov, Konstantin Tirronen
Institute of Biology Karelian Research Centre of RAS, Petrozavodsk, Russia

The Northwest of Russia is inhabited by the “big four” of predators – brown bear, wolf, lynx and wolverine. One of the most important functions of these animals is regulation of the number and state of their prey populations. Peculiarities regarding the ecology of large predators and their problems with humans have attracted researchers' attention more than once. We have carried out research in the study area for around 50 years. Recently we arranged a census count of the bear population. It appears that the total number of bears in the Russian North-West is 7600 animals. The number of other large predators according to winter route counts is: wolf – 1570 (Gubar, 2011), lynx – 1800 (Mosheva, 2011), wolverine – 450 individuals (Danilov, Tirronen, 2011). The popularity of hunting these animals and their value as hunting trophies has grown immeasurably during the last two decades. But more important for humans are the direct and indirect contacts between man and large predators. An analysis of the more than 50 years of data in our study area shows that there are no real cases of attacks on man by healthy wolves, bears or lynx. During the same time attacks by large predators on cattle and domestic animals have occurred, however the scale of this type of damage is currently much less than what it previously was.

Poster presentations

Thursday 26th September 2013, 15:30–16:30



PI. Protective role of 20 hydroxyecdysone (20 OH-Ecdysone) on lipid profile and body weight against high carbohydrate diet – induced metabolic syndrome in a gerbil model

Zineb Bellahreche¹, Hadjer Agoun¹, Maha Medjerab¹, Nesrine Semiane¹, Soumia Hammadi¹, Aicha Mallek¹, M. Abdelali², Ali Khalkhal¹, Yasmina Dahmani¹

¹USTHB University, Algiers, Algeria, ²Service d'anatomie pathologique, (CHU) d'Hussein Dey (Parnet), Algiers, Algeria

The photoecdysteroids, particularly 20 hydroxyecdysone, are natural compounds with many demonstrated effects on the physiological functions of vertebrates. The present study investigates the effect of 20 OH-Ecdysone on metabolic disorders induced by a high carbohydrate diet in a gerbil model (*Gerbillus tarabuli*). *Gerbillus*, nocturnal desert rodents, are native to North Africa (south western Algeria). Plasma lipid profile and body weight changes were estimated at the end of experimentation (3 months) in control and experimental groups of gerbils. Our investigation involved 19 *Gerbillus* divided into 3 groups. G1: control ($n=6$) received a natural diet (seeds, dry plants); G2: ($n=6$) were fed high carbohydrate diet (3g of barleycorn and 7g of dates - about 30 calories/day/ animal); G3: ($n=7$) received the same diet than G2 but supplemented with 20 OH-Ecdysone (1,2mg/day/kg body weight). After 3 months, gerbils were decapitated, their body weight measured, blood parameters (glucose, triglycerides, cholesterol, HDL-c, LDL-c) determined and adipose tissue weighed. High carbohydrate diet increased body weight, plasma glucose, triglycerides, cholesterol and LDL-c and decreased HDL-c in G2 as compared to the G1. However the same diet supplemented with 20 OH-Ecdysone resulted in a significant reduction of all biochemical parameters studied together with decreased body weight in the G 3 group as compared to G 2. These results indicate that 20 OH-Ecdysone seem to have a beneficial effect on the lipid profile and body weight of gerbils. In conclusion: our results indicate metabolic disorders induced by high carbohydrate diet and a protective effect of 20 OH-Ecdysone in *Gerbillus tarabuli*.

P2. Anticoagulant rodenticides in four mustelids in relation to food habits and habitat use

Morten Elmeros¹, Pia Lassen², Chris J. Topping¹, Aksel Bo Madsen¹

¹Dept. of Bioscience, Kalø, Aarhus University, Rønde, Denmark, ²Dept. of Environmental Science, Aarhus University, Roskilde, Denmark

Anticoagulant rodenticides (ARs) are widely used to control rodent populations. However, ARs also pose a risk for non-target wildlife species, and secondary poisoning of predators is widespread in many countries despite regulations to minimize exposure risk. We compared AR (bromadiolol, brodifacoum, coumatetralyl, difethialon and flocoumafen) detection rate and concentration in four mustelids: weasel (*Mustela nivalis*), stoat (*Mustela erminea*), polecat (*Mustela putorius*) and stone marten (*Martes foina*). ARs were analysed from a random sub-sample of specimens examined in food studies. ARs were detected at similar rates in weasels, stoats and stone martens (93% - 95%), but at a lower rate in polecats (58%). Total AR concentrations differed between species and season being significantly higher in stone marten than in the other species and highest in winter. The frequency of occurrence of rodents in the food of weasel, stoat, polecat and stone marten was 92%, 91%, 27%, and 33%, respectively. The variation in AR levels in mustelids may reflect differing feeding habits and habitat use. Stone martens typically forage near buildings, where rodent control is most intense. Thus, the stone marten's exposure to ARs via contaminated rodents is higher than the polecat's despite the fact that small rodents make up a similar and relatively small proportion of the diet. Weasels and stoats feed on rodents much more frequently, but as they forage in natural habitats the probability of exposure to AR per rodent prey item will be lower than the stone marten, resulting in similar overall exposure levels.

P3. First findings of house mouse (*Mus musculus* L) resistance to bromadiolone in Serbia

Goran Jokic¹, Tanja Scepcovic², Alexandra Esther³, Dragan Kataranovski⁴, Suzana Djedovic¹, Petar Vuksa⁵, Marina Vuksa¹
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Continuous use of bromadiolone for chemical control of rodent pests in Serbia and related control problems motivated an examination of its further applicability. Using an EPPO standard method, we evaluated the sensitivity of house mice to bromadiolone in a no-choice laboratory test. We used adult house mice from four locations in which resistance to bromadiolone was suspected. Twenty animals (10 females and 10 males) from each location were used in every no-choice test while housing them individually in standard cages. Baits were prepared by applying a liquid concentrate of bromadiolone to a medium-ground outmeal and wholemeal flour to a final concentration of 0.005% bromadiolone. During the 21 days of exposure, baits were offered in feeding bowls. Consumed bait was assessed weighed daily by weighing and replaced with fresh baits in clean bowls. All individuals from two locations died over a period of 3 to 15 days and resistance could be excluded. The same applied for most of the individuals from from the other two locations (Zemun Polje and Surčin), which died over a period of 4 to 20 days. Ten animals from these locations, however, survived the experiment. The first results revealed the presence of animals resistant to bromadiolone in the house mouse population from two Serbian locations. Resistance tests with F1 generation of the survivors and sequencing of VKOR-gene are going on. This study was funded by the Ministry of Education and Science of the Republic of Serbia (Grants: III 46008 and OI 173039).

P4. Population effects of fencing on common vole (*Microtus arvalis*) refuge populations

Angela Leukers^{1,2}, Jens Jacob¹

¹Julius Kühn-Institute, Federal Research Centre for Cultivated Plants, Institute for Plant Protection in Horticulture and Forestry, Vertebrate Research, Münster, North Rhine-Westphalia, Germany, ²Institute for Landscape Ecology, Westphalian Wilhelms-University Münster, Münster, North Rhine-Westphalia, Germany

At high abundances, common voles (*Microtus arvalis*) can cause significant losses in agriculture and forestry, because they can disperse from refuges (e.g. field edges) to arable land. To apply timely and spatially targeted management methods, sound knowledge about the distribution patterns of voles at field-refuge-boundaries is required. Fencing vole refuge habitats to inhibit dispersal is one proposed management method to protect fields. Population establishment on the field may be hindered that way, but the effects on demography of the enclosed populations have not yet been considered. Preventing dispersal may have negative effects on population growth rate and survival probability, which may support the management aim. The intention of this study, funded by the German Federal Environmental Foundation (DBU), was to investigate how inhibited vole dispersal influences the dynamics and demography of refuge populations. The study area was located in Saxony-Anhalt, core area of the common vole distribution in Germany. Sixteen grassland areas below wind energy plants were used as experimental refuges dispersed in a matrix of arable fields. Barrier fences were installed at 10 refuges to prevent dispersal. Capture-mark-release was applied in a two-year-study to compare population development in fenced and unfenced refuges. Inhibited dispersal may lead to lower maturation rates of young voles and to a higher proportion of agonistic behavior between males. These findings should be taken into account in refining vole management in agricultural fields.

P5. Diet categories that contribute to continuous breeding of multi-mammate mouse, *Mastomys natalensis* (Smith 1834) in irrigated rice field in eastern Tanzania

Loth Mulungu¹, Emanuel Mlyashimbi¹, Victoria Ngowo², Mashaka Mdangi³, Abdul Katakweba¹, Protas Tesha², Furaha Mrosso⁴, Magaret Mchomvu^{2,4}, Bukheti Kilonzo¹

¹Sokoine University of Agriculture, Morogoro, Tanzania, ²Rodent Control Centre, Ministry of Agriculture, Food Security and Cooperatives, Morogoro, Tanzania, ³MATI-Ilonga, Morogoro, Tanzania, ⁴Ilonga Agricultural Research Institute, Morogoro, Tanzania

The diet of *Mastomys natalensis* (Smith 1834) in irrigated rice cropping systems in eastern Tanzania was investigated from June, 2010 to May, 2012 in rice farm and fallow land habitats. The objective of the study was to determine the types of food categories consumed by *M. natalensis* in two habitats and various crop growth stages in irrigated rice ecosystems their potential influence the breeding patterns of the pest species. In both habitats and different growth stages of rice crop, plant material and seeds/grains predominated in the diet of *M. natalensis* while other food categories were in low quantities. It was generally concluded that *M. natalensis* in the area prefers feeding on plant materials and seeds/grains compared to other food categories, and that the two food materials account for its continuous breeding in irrigated rice production areas. It was recommended that management strategies are likely to be more effective when both seeds/grains and plant materials are not available in the environment, a condition which can influence reduction of recruitment levels for the pest.

P6. Spatial distribution of rodent pest species in irrigated rice field in Central eastern Tanzania

Loth Mulungu¹, Valency Sixbert¹, Victoria Ngowo², Mashaka Mdangi³, Abdul Katakweba¹, Protas Tesha², Furaha Mrosso⁴, Magaret Mchomvu^{2,4}, Bukheti Kilonzo¹

¹Sokoine University of Agriculture, Morogoro, Tanzania, ²Rodent Control Centre, Ministry of Agriculture, Food Security and Cooperatives, Morogoro, Tanzania, ³MATI-Ilonga, Morogoro, Tanzania, ⁴Ilonga Agricultural Research Institute, Morogoro, Tanzania

An understanding of the dispersion patterns of a pest is an important pre-requisite for developing an effective management program for the pest. In this study, live rodent pest trapping was carried out in two rice and two fallow fields for three nights consecutively from June 2010 to May 2012. *Mastomys natalensis* was found to be the most abundant rodent pest species in the study area, accounting for >95% of the rodent population. *Rattus rattus*, *Dasymys incommisus*, *Acomys spinosissimus* and *Grammomys dolichurus* comprised fairly small proportions of the population. The variance-mean ratio index of dispersion was used for determining spatial distribution pattern of the rodents in the area, revealing that the animals exhibited an aggregated distribution in space and over time. This distribution pattern was interpreted to indicate heterogeneity of the rice irrigated area due to changes of micro-climatic environment caused by agricultural practices, flooding and co-existence of rodent individuals. It was broadly concluded that such spatial patterns could serve as a tool for planning sampling plan of rodent pest species and decision making for establishing pest management strategies.

P7. Farmer's knowledge, attitude and practice of rodent management in lowland irrigated rice in Central-eastern, Tanzania

Loth Mulungu¹, Furaha Mrosso⁴, Abdul Katakweba¹, Mashaka Mdangi³, Protas Tesha², Victoria Ngowo², Magaret Mchomvu^{2,4}, Bukheti Kilonzo¹

¹Sokoine University of Agriculture, Morogoro, Tanzania, ²Rodent Control Centre, Ministry of Agriculture, Food Security and Cooperatives, Morogoro, Tanzania, ³MATI-Ilonga, Morogoro, Tanzania, ⁴Ilonga Agricultural Research Institute, Morogoro, Tanzania

Rodents are one of the major factors limiting crop production in Central-eastern Tanzania. A quantitative study was conducted at Hembeti village to obtain information on knowledge, attitude and practice of villagers with respect to rodent management. Structured questionnaires were administered to 30 randomly selected farmers and the results obtained were analysed by the SPSS vVer. 12 computer programme. It was revealed that 80–90% of the farmers cultivate maize and paddy in small fields ranging 0.5 to 1.5 acres. Rodents were reported to be the leading pests causing 20–60% crop losses both in fields and stores yearly. Methods used to assess presence of rodents in the area included presence of burrows and unearthed seedlings in fields and damaged grains and rodent noises in stores. It was further found out that farmers were responsible for the control of rodents and that 53% and 47 % were using rodenticides and physical killing methods, respectively. Financial constraints were reported to be the major factors limiting farmers to acquire and apply rodenticides. Need for training farmers on other management methods basing on ecological approaches was recommended.

P8. Game damage in forest and agricultural lands in Hungary

András Náhlik, Gyula Sándor, Tamás Tari

University of West-Hungary, Faculty of Forestry, Institute of Wildlife Management and Vertebrate Zoology, Sopron, Hungary

Game damage in agricultural areas and forest regenerations are a significant portion of wildlife management budgets, in some cases amounting to as much as 30–50% of total costs. Our analysis describes the financial status of game related damages. By correcting for fluctuating grain prices we can see from the results that game damage in agriculture correlates with changes in wild boar and red deer population size. In terms of forest damage, there is no correlation between size of damaged area versus population density of big game, which is mainly due to the growing number of fence-protected forests. While the financial compensation for damaged forest areas is only a portion of those paid out for agricultural damages, taking into consideration the expense associated with the protection of forests then the costs are increasingly similar. Problems are furthermore enhanced by the effort of forest management and nature conservation to increase the ratio of gradual forest regeneration and that of continuous forest covers. Economic analysis indicates that under smaller population densities financial management of big game may be more favorable. Sometimes game damage requires the intervention of authorities. However, limited resources of the hunting authority do not allow for the establishment of suitable planning guidelines and follow-up. During planning they are strictly concerned with preliminary data sets from which hunting quotas are determined, while they do not take into account the problem of game damage on nature conservation and forest management.

P9. Rats *Rattus norvegicus* and their impact on breeding birds on islets in Roskilde Fjord, Denmark

Thomas Bregnballe¹, Morten Elmeros¹, Erik Hansen², Pelle Andersen-Harild³, Peter Sunde¹

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Rats *Rattus spp.* can be serious predators on adults, eggs and chicks of seabirds and ground nesting colonial waterbirds. Breeding numbers of coastal birds were monitored annually on 25 islets in Roskilde Fjord during 1978–2012 and occurrence of rats was monitored since their first appearance in 1987. Rats occurred on 12 different islets located 190–800 m from the mainland. Rats mainly preyed on eggs, chicks and adults of black-headed gull *Chroicocephalus ridibundus* and terns, *Sterna spp.* Predation by rats lead to massive emigration of black-headed gulls with overall breeding numbers declining from c 15,000 to 7,000 pairs. Islets with colonies of up to 2,300 pairs were abandoned, and re-colonizations of some islets took several years. Breeding numbers of common gull *L. canus*, common tern *S. hirundo*, arctic tern *S. paradisae* and avocet *Recurvirostra avosetta* were affected by occurrence of rats on some islets. There were no indications of effects on breeding numbers of mute swan *Cygnus olor*, mallard *Anas platyrhynchos* and herring gull *L. argentatus*. In attempts to exterminate rat populations anticoagulant poisons were used as powder placed in rat burrows, and as edible baits (grain, paraffin blocks and apples) offered in feeding boxes. Rat control was most successful when paraffin blocks were used during winter combined with powder in early spring if needed. It is concluded that attempts to eradicate rats had positive effects on some of the species of breeding coastal birds.

P10. Using agent-based simulation to predict and manage rodenticide resistance development

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Simulation using highly detailed dynamic environments and agent-based population modelling has been used to develop highly detailed impact assessment for pesticide effects on non-target organisms, but these have not yet been applied to management of the pest species themselves. However, the agent-based approach provides the potential to not only simulate pests but also their genetics. Here we present some initial simulations assessing the development of resistance assuming a vole target species in an orchard landscape. We assume a natural frequency of the resistance gene and neutral genetics as a baseline scenario against which we compare scenarios of resistance development assuming treatment with highly effective rodenticide in combination with herbicide treatment and local habitat management to remove source habitats. The results are presented both at a local large orchard scale, but also at a 10 x 10 km landscape scale. The factors that affect resistance development time are shown to be related to management regime, local environmental conditions, and landscape structure. These comprehensive simulation approaches provide a new way to evaluate pest management and could be extended to cover other species such as rats.

P11. Impact of changes to the requirements for the on-farm burial of rats poisoned with rodenticides

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In the UK, the Wildlife Investigation Incident Scheme (WIIS) receives wildlife carcasses and samples from carcasses to analyse for the presence of a wide variety of pesticides. Where pesticides are identified, any investigation aims to establish whether these chemicals have been used under the conditions of approval (approved use), have been misused or abused. Since 2000, liver tissues from all raptors and selected wild mammals have been routinely tested for anticoagulant rodenticide residues; the evidence suggests there is widespread non-target contamination. To help reduce this contamination, the Scottish Environment Protection Agency (SEPA) produced a Position Statement in March 2009, outlining the requirements for the on-farm burial of rodents poisoned with anticoagulant rodenticides. Prior to this, no Position Statement was in place. See http://www.sepa.org.uk/waste/waste_regulation/guidance__position_statements.aspx. This poster examines WIIS data before and after the production of the Statement to assess the impact of these changes, and possible effectiveness of the desired aim.

PI2. The rise and potential fall of feral raccoon dog (*Nyctereutes procyonoides*) in Denmark

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The raccoon dog (*Nyctereutes procyonoides*) originates from Eastern Asia, but has been introduced in Europe as a fur game and for fur farming. The species is established in most of Eastern Europe and is spreading westward. Raccoon dogs have been recorded occasionally in Denmark since 1980 as escapees from fur farms and private pets. In 2007–2008, the number of observations of raccoon dogs increased markedly in the northwestern parts of the country indicating that the escapees had established a self-reproducing feral population. Furthermore, supplementation to the population in Denmark from the south may occur with increasing frequency as the population in Germany expands. In 2010 the Danish Nature Agency implemented an action plan aiming at eradicating the raccoon dog population in Denmark by 2015. Annual statistics of culled and road killed raccoon dogs in Denmark in 2008–2012 suggests that the species is now widespread in Jutland, and that the density is highest in the northwestern areas, where the feral population was established. Using statistics of culled and road killed raccoon dogs and population viability analysis (VORTEX), population development and potential effects of different culling intensities is simulated and evaluated to the objectives of the action plan.

PI3. Alien predation in wetlands – raccoon dog control and the breeding success of water birds

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Alien predators have the potential to strongly affect their prey populations. We studied the impact of raccoon dog removal on waterbird breeding success in semiurban wetlands in Finland during 2002–2004. Our hypothesis was that the omnivorous raccoon dog plays a role in waterbird breeding success by depredating nests. We used two raccoon dog removal wetlands and two control areas. In the first study year we hunted no raccoon dogs, but during the following two hunting seasons we conducted raccoon dog removal. In our control wetlands, hunting was not allowed during the study period. We also collected data on raccoon dog density, estimated the raccoon dog hunting bag and observed waterbird breeding success. In addition, we performed nest predation experiments in eight eutrophic wetlands. Our experiments showed that the raccoon dog hunting bag in eutrophic wetlands may be surprisingly high. We captured 8.6–20.0 animals per km² in our removal wetlands and succeeded in reducing the density of raccoon dogs. Both our nest predation experiment and field data indicated that raccoon dogs impact the breeding success of waterbirds in eutrophic wetlands. All of our study birds – mallard *Anas platyrhynchos*, widgeon *A. penelope*, mute swan *Cygnus olor*, great crested grebe *Podiceps cristatus*, lapwing *Vanellus vanellus* and marsh harrier *Circus aeruginosus* – improved their nesting success after raccoon dog removal. In the control wetlands there were no consistent changes in nesting success of waterbirds. Our results indicate that alien predator removal can be an important tool in wetland management.

P14. Fencing young forest plantations to avoid deer damage: the negative impact upon wildlife food and cover

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Fieldwork was performed at the Niepołomicka Forest, a 10,800 hectare lowland forest situated 35 km east of Kraków. Publications on biomass of deer forage and data from Forest Service were used to calculate impact of fencing. Populations of red and roe deer were assessed using snow tracking and driving censuses. The surface area of the young forest plantation amounts to 540 hectares (n=344) of which 372.2 hectares are fenced (n=214). In summer, a hectare of deciduous forest (Tilio-Carpinetum) offers on average 627 kg dry weight of potential forage, of which 184 kg dry weight is located in forest plantations. The fenced plantations decrease the potential forage supply by 126.8 kg dry weight/hectare, i.e. by 20.2%. In mixed forest (Pino-Quercetum) the biomass of potential forage in summer amounts to an average of 890 kg dry weight/hectare, of which 387 kg is provided by plantations. Fencing reduces that amount by 266.6 kg dry weight/hectare, i.e. by 29.9%. In the last decade, the area of fenced plantations in the Niepołomicka Forest has increased each year from 54.0 to 181.7 hectares/year. Also the population density of deer has increased, and recently stands at 47.4 red deer/1000 hectares, and 148.9 roe deer/1000 hectares. In 2011, the cost of erecting fencing was 84,900 euro. Fencing the plantations increases the pressure of deer foraging on unfenced portions of forest, particularly on plantations and farmlands adjacent to forests. Therefore, rational reduction of deer numbers would be a logical solution instead of increasing the area of fenced plantations.

P15. Biodiversity of helminth fauna of wild cloven hoofed animals in highlands of the Kyrgyz republic

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Knowledge of helminth biodiversity and their relation with hosts enables identification of the formation and function of parasitic systems in nature and development of environmentally safe methods to prevent parasitic diseases among animals. The study of helminth fauna of wild cloven hoofed animals was conducted in natural conditions of the Naryn State Reserve. The helminth study encompassed marals (*Ervus elaphus sibiricus* S.) and roe deer (*Capreolus capreolus* L.). The results of our research indicate that the helminth fauna of marals within the conditions of Naryn State Reserve is formed by at least seventeen types of parasitic worms. The following parasites were discovered: *Dicrocoelium lanceatum*, *Trichostrongylus capricola*, *Haemonchus contortus*, *Dictyocaulus filarial*, *Monezia expansa*, *Neoscaris vutulorum*, *Trichocephalus ovis*, *Paramphistomum cervi*, *Fasciola hepatica*, *Parafasciolopsis fasciolaemorphia* as well as endamebas - *Eimeria crandallis*, and *Eimeria ovinoidalis*. The helminth fauna consists trichostrongylidae (58.7%) and oocysts of eimeria (38.9%). In the reserve area 14 species of helminths were recorded from roe deer: *Parafasciolopsis fasciolaemorphia*, *Dicrocoelium lanceatum*, *Paramphistomum cervi*, *Echinococcus granulosus*, larvae, *Moniezia expansa*, *Chabertia ovina*, *Oesophagostomum venulosum*, *Trichostrongylus capricola*, *Haemonchus contortus*, *Dictyocaulus eckerti*, *Ostertagia ostertagi*, *Bunostomum trigonocephalum*, *Setaria labiato-papillosa* and *Trichocephalus ovis*.

PI6. Parasitological situation of invasive muskrat (*Ondatra zibethicus*) in Lithuania

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The muskrat are not only subsumed as an invasive species in Lithuania but also regarded as a pest animal. The muskrat could be infected by parasites of many species which may reduce muskrat populations and, moreover, affect human health (for example, 203 echinococcosis cases were recorded in Lithuania in 2002–2012). Parasitological investigations of 52 muskrat individuals were carried out across Lithuania in 2006–2007 and in 2011–2012. 11 species of helminths were found: 8 trematodes (*Echinostoma revolutum*, *Echinostoma coalitum*, *Echinostoma* sp., *Plagiorchis elegans*, *Skrjabinoplagioorchis ondatrae*, *Psilotrema spiculigerum*, *Psilotrema simillimum*, *Psilotrema* sp.) and 3 cestodes (*Echinococcus multilocularis* (larvae), *Hydatigera taeniaeformis* (larvae), *Tetratirotaenia polyacantha* (larvae)). Differences in helminth infection prevalence of muskrat was observed between years: the highest E(%)=90.0 in 2011 and the lowest E(%)=59.1 in 2007. The diversity of the helminth community (Shannon-Wiener index) infecting muskrat varied from 0.77 to 1.17. In most cases helminths were aggregated among the hosts (aggregation index varied between 1 to 192.11). Moreover, these data were compared with older results as the helminth fauna of the muskrat was studied in 1973–1976 and in 2001. Muskrat were also tested for the infective diseases tularemia and toxoplasmosis. Our data showed that muskrat is a reservoir of many diseases and the number of known diseases is increasing from year to year. The study was supported by the Research Council of Lithuania (grant No. LEK-14/2012).

PI7. Moose-vehicle collisions occur earlier in warm springs

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Early summer is the most important moose-vehicle collision (MVC) season in Finland after autumn. We surveyed how the timing of early summer MVCs changed during 1989–2011 using data of daily collisions that occurred throughout a 4-month season (April–July). By pooling national road districts, we first divided Finland into five study regions and calculated the annual dates by which 50 % of all the MVCs of the study season had taken place (median dates). Then, using all of the nine road districts as areal units, we determined if the beginning of the growing season and the median dates of MVCs were correlated. A total of 13,233 MVCs occurred during the study period. In every region, the number of MVCs was the lowest in April but started to increase in May and was highest in June or July. The timing of the median dates for MVCs in all regions shifted to an earlier date, and was positively correlated with the beginning of the growing season in every road district. We believe that the beginning of the growing season correlates with the timing of moose spring migration from wintering areas to summer pastures and, further, with the timing of MVCs. Regardless of the ultimate reason behind our findings, we emphasize the practical importance of our results: how can the onset of spring help predict timing of spring MVCs. We recommend that warning campaigns informing road users coincide with the annually changing MVC season.

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